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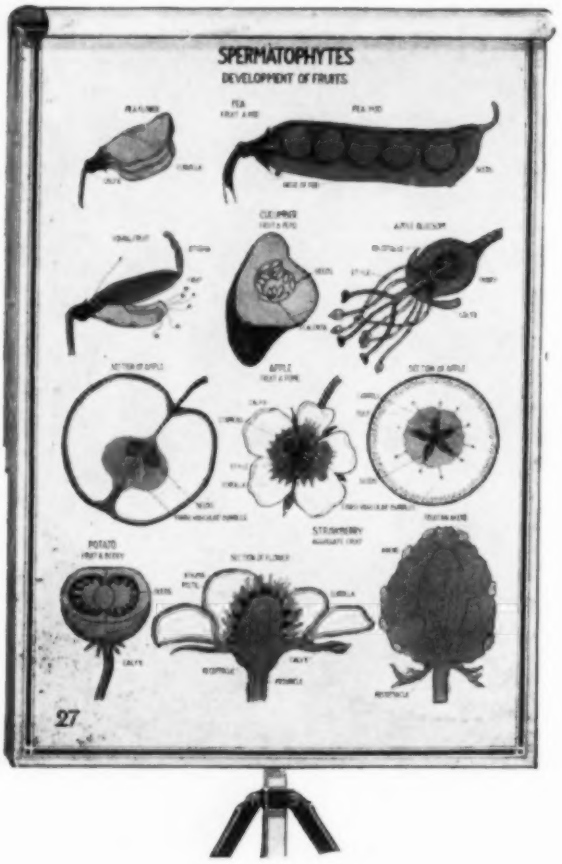

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Comments on Undergraduate Research at Kings College
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The Effects of Temperature on the Growth of Peas
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The Chemical Corps: A Historical Sketch Of the Army's Chemical Branch

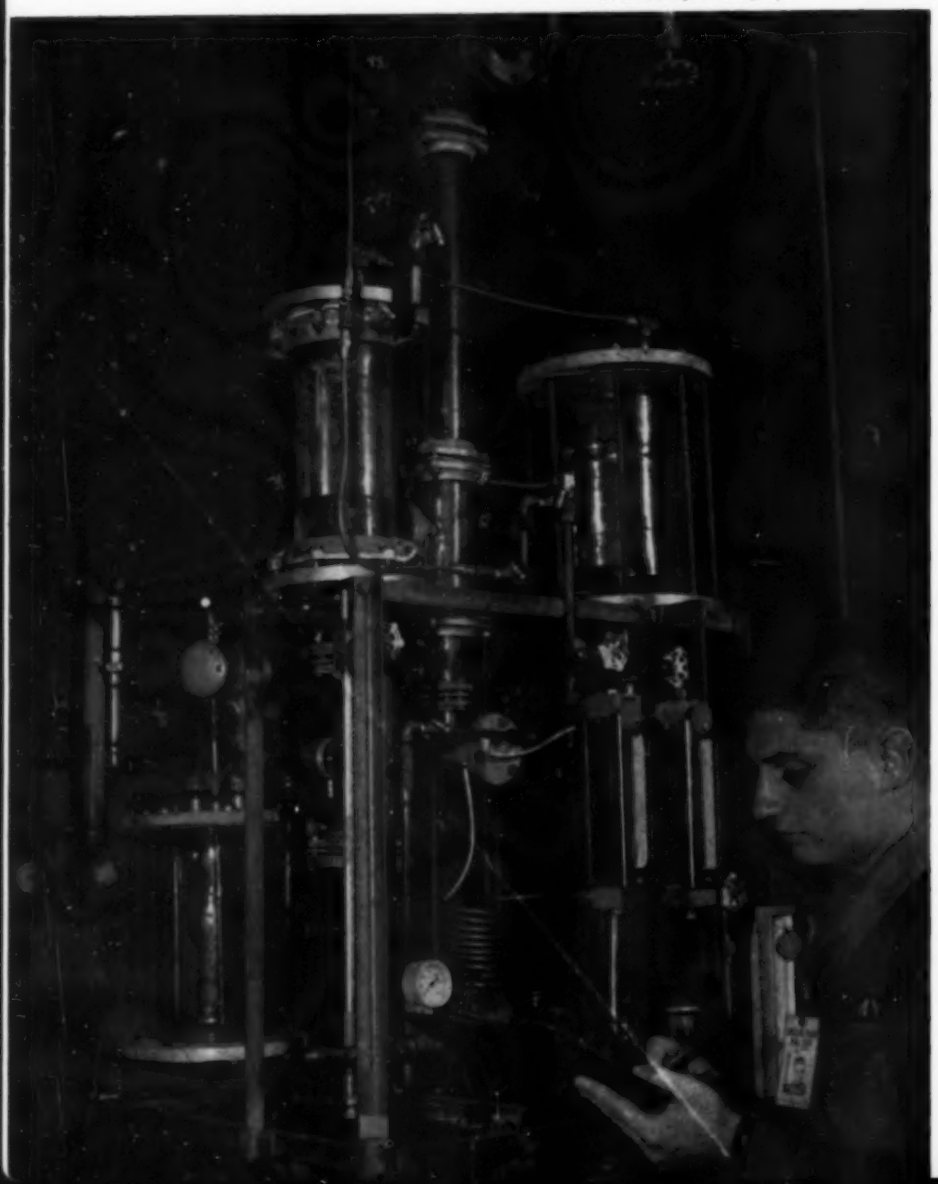
• **Wyndham D. Miles, Ph.D.**
NATIONAL ARCHIVES, WASHINGTON, D. C.

Until March 1960 Doctor Miles was with the U. S. Army Chemical Corps Historical Office, Army Chemical Center, Maryland.

You will find this article most informative.

●

This year marks the forty-second anniversary of the Chemical Corps as a branch of the United States Army. Begun in 1918 as an emergency measure, the Chemical Warfare Service, as it was called in those days, teetered, after the Armistice, on the brink of disbandment until 1920 when Congress made it a lasting part of our armed forces. Today the Chemical Corps has several installations in the United States. The home of the Corps is Army Chemical Center, Maryland, on a peninsula jutting into Chesapeake Bay about twenty miles northeast of Baltimore. Here are located the Chemical Warfare Laboratories where scientists work on toxic agents, screening smokes, protective masks and other things. Here also is the Corps' Engineering Command where chemical and mechanical engineers design chemical plants, develop chemical warfare devices, and carry out other engineering tasks involved in the running of a large industrial organization; the Corps' Materiel Command which procures, stores, and issues chemicals and chemical equipment for the Army; the Chemical Corps Board, a group of senior officers and scientists who carry out long range studies to guide research and development and determine the proper application of chemical, biological, and radiological warfare in future military operations; the Chemical Corps Museum, where is displayed American, British, German, French, Italian, Japanese, and Russian equipment used from World War I onward; the Operations Research Group, an organization of mathematicians and other scientists who assess the most promising weapons systems and protective systems for exploitation; and the Executive Secretary of the Chemical Corps Advisory Council, a committee set up to advise the Corps.



An enlisted chemical engineer recording data of a trial run in a pilot plant at the Army Chemical Center.
U. S. Army Photograph

At Frederick, Maryland, is Fort Detrick, location of the Corps' Biological Warfare Laboratories. In the desert southwest of Salt Lake City, Utah, lies Dugway Proving Grounds, where the Corps tests chemical agents weapons, and equipment. Outside Denver, Colorado, stands Rocky Mountain Arsenal, site of a chemical plant for the manufacture of nerve gases. Other chemical plants are at Pine Bluff Arsenal, Arkansas; Sheffield, Alabama; Newport, Indiana; and Army Chemical Center. The Corps also has a school at Fort McClellan, Alabama, where it teaches chemical warfare to Army, Navy, and Air Force officers.

The Corps, however, has not always been a large, widespread organization. When the United States entered World War I in April 1917, the Army did not have a Chemical Corps. The work was scattered over parts of the Army, with the Ordnance Corps being responsible for supplying toxic agents, the Medical Corps handling gas masks, the Signal Corps providing gas alarms, the Corps of Engineers providing combat troops, and the Bureau of Mines of the Department of the Interior directing research and development. The Army had no chemical warfare laboratories and most of the work was done at universities—Johns Hopkins, Yale, American University, Catholic University, Chicago, Wisconsin, and so on—under the supervision of college professors. In June 1918, President Wilson ordered all the groups involved in chemical warfare fused into one organization, the Chemical Corps. By the end of the war there

were more than a thousand scientists in the Corps' technical division, making it probably the largest research organization that had been gathered together anywhere in the world up to that time.

But the Chemical Corps had been brought into existence under the President's wartime powers and it was only a temporary organization. It disintegrated after the armistice and would have disappeared entirely had not Congress designated it as a permanent part of the Army in 1920. Large during the war, with chemical plants at several locations and twenty thousand men in uniform, the Corps was now reduced to one installation, Edgewood Arsenal, now Army Chemical Center. The small Army budgets of the 1920's and early 1930's gave the Corps little to work with. Chemical plants at Edgewood fell apart from lack of money to operate or maintain them. Only a handful of chemists could be employed. Under the circumstances chemical warfare research barely inched forward in the United States.

During the 1920's several branches of the government discovered that the specialized abilities of the Chemical Corps could be useful in attacking peacetime scientific problems. For a number of years the Corps' chemists and toxicologists aided the farmer by testing hundreds of compounds and mixtures in a search for a boll weevil insecticide. They assisted the Philippine Island Department of Agriculture in a war against locusts and the Hawaii Sugar Planters' Association against field rats. They worked with the National Research Council in finding poisons that would destroy shipworms and other marine borers. They developed ship-bottom paints to prevent barnacles and similar marine creatures from clinging to the undersides of ships. Following the Cleveland Hospital Clinic fire, May 15, 1929, in which more than 100 people were suffocated by fumes from burning X-ray films, the Corps studied the spontaneous combustion of film and then widely publicised the danger of storing film improperly.

The outbreak of World War II was the dawn of a new day for the Corps. The Army's budget shot upward and with it the appropriations for chemical warfare. New laboratories started to rise. The Corps obtained proving grounds in Utah, at Bushnell, Florida, and on San José Island off the coast of Panama (the latter two since given up). Chemical plants were built at Huntsville, Alabama; Niagara Falls, New York; Pine Bluff Arsenal; Marshall, West Virginia; Seattle, Washington; Denver, Colorado; Azusa, California; St Louis, Missouri, and other places. Some of these plants were sold after the war.

World War II also brought the Corps additional responsibilities. Apprehensive that the Germans or Japanese might open biological warfare against troops, farm animals, or crops, the government began research on the subject, slowly at first but with considerable vigor by 1943. The Chemical Corps received the assignment to handle this line of work, and it established suitable laboratories at Fort Detrick. Here scientists developed techniques for detecting invasions of microorganisms that would herald biological attacks, and for protecting troops and the civilian population. From the laboratories since the war have come important research papers on plant growth regulators, chemical defoliants, the usefulness of beta-propiolactone as a disinfectant, the sterilization of sewage by irradiation, anthrax vaccine, botulinum toxoid, samplers for collecting pathogens and separating them by size, and other contributions to the public welfare.

Along with biological warfare World War II eventually brought the Corps another mission, that of being the Army's staff agency for research in defense against radiological warfare. Radiological warfare is not concerned with the initial blast and heat effects of a nuclear explosion, but with the radioactive fall-out and the nuclear radiation. The Corps has the job of protecting troops against such fall-out and radiation. For this purpose it has developed simple instruments with which the combat soldier can detect radiation, it has experimented with smoke screens as a means of protecting cities against nuclear and heat radiation, and it has tested vacuum cleaners, street sweepers, fire hoses, compressed air and other methods of removing fall-out from residential areas. The Corps is also responsible for the disposal of the Army's radiological waste. At present the waste is placed in concrete casings and sunk at sea. Experiments are being made to store the waste in some other manner that will be more efficient and will permit the material to be reclaimed if it is later found useful.

Chemical Corps scientists are largely civilians, but a number are reserve officers, often just out of college, or enlisted men with degrees and experience. The men in the latter category are the Scientific and Enlisted Personnel, generally referred to as S&E's. To be designated an S&E, a young man upon induction into the Army must have a bachelor's degree plus one year of graduate work or six months or more of experience. Since 1948 when the Army set up a program to place drafted scientists in military laboratories, several thousand chemists, physicists, biologists, and other professional people have fulfilled their selective service obligations as members of the Chemical Corps.

The Chemical Corps has always been the smallest technical service in the Army, receiving in recent years about one one-thousandth of the defense budget. But in the future there may be a larger role for the Corps in our national defense. For some years chemists, physiologists, and other scientists have been developing the so-called psychochemicals, which can incapacitate a person temporarily without leaving harmful after effects. Furthermore civil defense planners have been taking a closer look at CBR, as chemical, biological, and radiological warfare is called, with the result that they may place more emphasis on CBR and jog the public into learning what CBR is about. There is a potential of considerable importance in the Corps' work, and military thinking at the present time indicates that the Corps will have more to do in the future than it has in the past.

REFERENCE

For a detailed account of the Chemical Corps from its beginnings in 1917 to the end of World War II the reader is referred to three volumes appearing in the series THE UNITED STATES ARMY IN WORLD WAR II sponsored by the Office, Chief of Military History, Department of the Army. The first volume, *The Chemical Warfare Service: Organizing for War*, by Leo P. Brophy and George J.B. Fisher came from the Government Printing Office in 1959. Volume two, *The Chemical Warfare Service: From Laboratory to Field* will appear in 1960, and volume three, *The Chemical Warfare Service: Chemicals in Combat*, in 1962.

Patterns in the Physical Sciences

• **Sister M. Ignatia, I. H. M.**
MARYGROVE COLLEGE, DETROIT, MICHIGAN

A non-technical presentation of the concept of pattern in the physical sciences with illustrations drawn from astronomy, organic chemistry, atomic physics, and nuclear physics. The conclusion is reached that scientific truth lies in the pattern.

●

The "rage for order" is one of the fundamental driving forces that motivate physical scientists. Their fundamental assumption is that there *is* order in the universe, and while it is not easy to discover, it is discoverable. As C. A. Coulson reminds us in his little book, *Science and Christian Belief*, "the raw material of science is the set of experiences, observations, measurements, of the scientist; and his task is to find a pattern of relationships between these experiences."[1]

When the pattern or design is first sensed, it is called an *hypothesis*, and if this pattern of relationships is seen to extend its range, it is called a *theory*, a model or mental picture in terms of which scientific facts and laws are coordinated and explained. Now a scientific *law* is essentially a brief description of the results of observations and measurements, essentially a summarizing statement of experimentally observed facts. That is why laws do not change as theories do. Scientific laws, however, do not become immediately evident to the gatherer of data; the pattern is not at once apparent.

Tycho Brahe, who lived before the invention of the telescope, spent twenty years carefully measuring and recording the positions of the planet Mars, but he perceived no pattern in his data. When he died in 1601, these data became the property of Johann Kepler, his young student assistant. Kepler stopped taking measurements. He was a man of grand concepts and schemes, not all of them worth remembering, but this time his imagination was fired with the concept of the then revolutionary Copernican or heliocentric theory, a theory that Tycho Brahe had held in disdain. As Kepler studied the data collected by his master, three related patterns slowly became evident, and after an immense amount of calculation, of trial and error, Kepler stated his three laws of planetary motion and showed that they were consistent with Tycho Brahe's data on Mars. Kepler had no idea why his laws worked, nor did he know that they were the result of a single more fundamental law—Newton's law of gravitation. He simply knew that the neatest way of summarizing the data of Tycho Brahe was to state that

1. Mars moves in an elliptical orbit with the sun at one of the two foci of that ellipse.
2. Mars moves in this orbit at such a speed that an imaginary line connecting it with the sun sweeps out equal areas in equal lengths of time.
3. The time required for Mars to travel once around its elliptical orbit is a precise mathematical function of its average distance from the sun.[2]

Kepler assumed that Mars was a typical planet and that when a sufficient amount of data was gathered on the other planets, the same pattern would be evident. The name "Mars" in his laws could then validly be replaced by the more general term, "a planet."

Struggle between the adherents of rival theories, or patterns, has marked the great epochs of astronomy. This was true of the time of Kepler when the Copernican and Ptolemaic theories competed for supremacy. It is true today when the evolutionary universe and the steady-state theories are rivals.

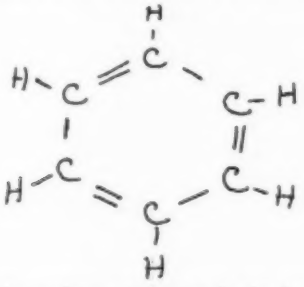
The theory of the evolutionary universe postulates that creation of all matter took place at one time and in a relatively small space, and that since that time the universe has been expanding. The galaxies of stars are becoming more and more widely separated, and the stars themselves are evolving according to a pattern, the details of which are dependent upon the type of the particular star. The steady-state theory, on the other hand, holds that the large scale features of the universe remain essentially unchanged, and that since the universe is apparently expanding, continuous creation of hydrogen atoms must be going on in the vast spaces between the galaxies. Phenomena predicted by these two rival theories are currently being sought by a large number of astronomers, and the astronomical journals carry frequent reports of experiments devised to test the two theories. The September, 1956, issue of the *Scientific American* carried companion articles on the two theories, "The Evolutionary Universe" by the famous physicist and popular writer, George Gamow,[3] and "The Steady-State Universe" by its chief protagonist, Fred Hoyle.[4, 5]

Astronomy is not, however, the only physical science in which the concept of pattern plays a major role. It is most striking, for instance, in organic chemistry where a special type of pattern, the structural formula, shows the architecture of each molecule. Experiments can be performed and measurements taken which yield upon calculation the number and type of the atoms present in a molecule of a given substance. Benzene, for example, contains exactly six atoms of carbon and six atoms of hydrogen in each molecule, but how are these atoms arranged, so that the unit of benzene is always this molecule, C_6H_6? Why is this combination the unit instead of C_3H_3, or C_2H_2, or even CH? And since benzene is only one of a large number of different compounds, and one of the simpler ones at that, the task of relating the large scale properties of a compound to its internal structure would be impossible without the aid of some guiding principles, essentially patterns, and some method of representing molecular architecture. The solution came in 1858 when Archibald Scott Couper, a Scotch chemist, and Fredrich August Kekulé, a German chemist and once a student of architecture, showed how diagrams called structural formulas could be used to represent the arrangement of atoms within a molecule.

Two of the guiding principles used by Couper and Kekulé were literally "dreamed up" by Kekulé. He was in London when he had the first of his two most famous dreams. In his own words, ". . . I fell into a reverie, and lo! the atoms were gambolling before my eyes . . . I saw how, frequently two smaller atoms united to form a pair; how a larger one embraced two smaller ones; how still larger ones kept hold

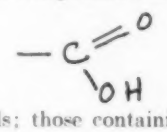
of three or even four of the smaller; whilst the whole kept whirling in a giddy dance. I saw how the larger ones formed a chain."[6]

The second of his two most famous dreams came when he was in Ghent dozing before his fire. Again the atoms gambolled before him, forming chains which twisted with a snake-like motion. "But look! What was that? One of the snakes had seized hold of its own tail, and the form whirled mockingly before my eyes. As if by a flash of lightning I awoke."[7] The dream of the snake seizing its own tail gave Kekulé a clue to the ring-like structure of the benzene molecule, a clue which led to the structural formula,

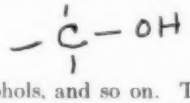


which shows six carbon atoms and six hydrogen atoms joined in a single molecule.

There is also another way in which patterns are of great importance in organic chemistry. If the reactive groups of atoms in a molecule of a compound are known, it is possible to predict quite accurately the chemical behavior of that molecule. All compounds containing a



group behave as acids; those containing a



group behave as alcohols, and so on. The identification of these reactive groups can now be made by physical rather than chemical methods and two of the most important tools for this purpose are infrared and ultraviolet absorption spectroscopy.

As we descend from the level of objects large enough to be seen to the level of the molecule, which is the smallest particle of a substance that has the properties of that substance, and continue to descend to the level of the atoms which make up molecules, the importance of pattern actually increases. We find that all the atoms of a particular isotope, carbon twelve, for example, are exactly alike, in fact identical, regardless of the history of the atom. The C^{12} atoms in a benzene molecule are identical with those in a diamond or in a lead pencil.

To go back to the solar system, the motion of the planets is still accurately described by Kepler's three laws of planetary motion. Elliptical orbits of any size are possible, and as Victor F. Weisskopf, the president of the American Physical Society, points out:

> The specific orbits in which our planets actually are found cannot be determined by the fundamental law of motion, but by so-called 'initial conditions,' those prevailing when the system was being formed . . . Slightly varying conditions at the beginning would have produced different orbits. We now have good reason to believe that there are many other solar systems among the stars whose planets have orbits quite different from those in our own system.[8]

Su-Shu Huang estimates that at least a few per cent of all stars are accompanied by planets,[9] and in a recent issue of *Sky and Telescope* Frank D. Drake of the new National Radio Astronomy Observatory at Green Bank, West Virginia describes Project Ozma which has recently been initiated to try to detect possible radio signals from the planets of other stars. If there is rational life on any of these planets, we may be able to distinguish artificial radio signals from those emitted by radio stars and by the hydrogen atoms in interstellar space.[10]

Nevertheless, while the initial conditions under which any planetary system is formed are important in determining the orbits of the planets, these orbits may also be radically changed by some interference from outside the system once its formation is complete. The close passage of another star, for example, would cause a thorough change of the orbits of our planets. In stark contrast with this phenomenon, however, is the identity of all the individual atoms of the same isotope, regardless of whether those atoms were formed billions of years ago in the interior of a star, or were the result of a radioactive change that took place on earth just today. The identity of these atoms is completely unchanged by collisions with other atoms or molecules. Collisions between nitrogen and oxygen molecules in air take place literally millions of times each second, yet after each collision, the atoms emerge completely restored to their original form.

When we consider the fact that the electrons in the atomic orbits of all the different elements are identical, we see that the nature of the patterns that appear in atomic physics are quite different from those that we see in large-scale or classical physics. Why do all the electrons have exactly the same mass and exactly the same charge? That is just one of the many questions that have not yet been answered.

If we descend again from the small to the still smaller and consider the nucleus of an atom, which has a diameter of about one one-hundred thousandth of the diameter of the atom itself, we encounter still more surprising patterns. All the protons in the nuclei of all the different elements are identical in charge and mass, and it is precisely the number of protons in any particular nucleus which determines which element is present. If there is only one proton in the nucleus of an atom, that atom is hydrogen; if there are ninety-two protons, the atom is uranium. Similarly, the neutrons in the atoms of all the elements are identical, and it is their number in a particular nucleus which determines which isotope of the element is present. In two chlorine atoms, which are both chlorine because they both have seventeen protons, the one with eighteen neutrons is called Cl^{35} and the one with twenty neutrons is called Cl^{37}. Now Cl^{35} atoms are more abundant than Cl^{37} atoms, but the ratio of the abundances of these isotopes is the same, regardless of where we obtain our samples of chlorine gas.

When we consider the other so-called "fundamental particles" besides the electron, the proton, and the neutron, the complexity of the pattern is greatly increased. At least

nineteen "fundamental particles" have been identified thus far, and much of this has been done by studying the trajectories left by the particles as they pass through thick photographic emulsions[11] or through a bubble chamber.[12] From the study of these identifying tracks have been determined the charge (positive, negative, or zero), the mass, and even the average lifetime and decay scheme of most of these tiny particles. Apparently only the proton, the electron, and the neutrino, among the known "fundamental particles" are stable.

At least nine of the "fundamental particles" are mesons, so called because their masses are between the mass of the electron and the mass of the proton which is 1,836 times as heavy as the electron. Mesons seem to be involved, in some way we do not yet understand, in the strong forces which hold as many as ninety-two protons and 146 neutrons in the tiny nucleus of the atom of U^{238}, the most stable isotope of uranium. Hideki Yukawa, a Japanese physicist, postulated the existence of mesons as early as 1935. He suggested that nuclear forces were exchange forces caused by the interaction of protons and neutrons with themselves and with each other, in which mesons are emitted and absorbed. "When a proton and a neutron interact, he postulated, the proton may emit a positive meson which is absorbed by the neutron. In this process the proton loses its positive charge and becomes a neutron, while the neutron gains a unit of positive charge and turns into a proton."[13] Mesons that interact strongly with protons and neutrons were discovered in the cosmic rays in 1947.

We know very little of the structure of the atomic nucleus, much less, in fact, than we know of the arrangement and movements of the electrons outside the nucleus. To help coordinate and explain the mass of data on nuclear reactions that is being rapidly accumulated, several different models or mental pictures, essentially patterns, have been proposed. One of these models, proposed by Niels Bohr, considers the nucleus as a liquid drop.[14] Another, an optical model, pictures the nucleus as a somewhat cloudy crystal ball.[15] A third, independently proposed by Maria G. Mayer of the University of Chicago and J. D. H. Jensen of Heidelberg, is called the shell model. This has been very successful in explaining the high stability of nuclei with an even number of protons and an even number of neutrons.[16]

We see from the evidence presented above the importance of the concept of pattern in the physical sciences, an importance so great that C. A. Coulson says that

> As for these patterns they are mental constructs of our own, and their ultimate sanction is that they do fit together. Scientific truth means coherence in a pattern which is recognized as meaningful and sensible. It is acceptable only so long as it does 'hold together,' without internal contradiction, and is able to grow, either by prediction of new phenomena or the absorption of old ones.[17]

He points out further that

> Every true discipline of the mind shares this common search for unifying concepts. . . . It is the pattern we value. The facts, which are the raw material of the pattern, yet do not belong to it; they are of relatively little value by themselves. Only the pattern gives insight.[18]

It is insight, as well as order, that we seek in the physical sciences.

NOTES

1. Pp. 33–34.
2. Wm. T. Skilling and R. S. Richardson, *A Brief Text in Astronomy*, pp. 79–82.
3. Pp. 136–140+.
4. Pp. 157–160+.
5. On June 25, 1959, at the University of Colorado at Boulder, a public debate was held on the two theories by George Gamow of that university and Thomas Gold, now head of astronomy department at Cornell University and one of the two men who proposed the steady-state theory in 1948. H. Bondi and T. Gold, *Monthly Notices of the Royal Astronomical Society*, 108 (1948), 252–270.
6. F. R. Japp, "Kekulé Memorial Lecture," *Trans. of the Chemical Society*, 1898, quoted by A. Findlay, *Chemistry in the Service of Man*, 8th ed., p. 200.
7. *Ibid.*, p. 201.
8. "Quality and Quantity in Quantum Physics," *Daedalus*, (Fall, 1959), 593.
9. "The Problem of Life in the Universe and the Mode of Star Formation," *Publications of the Astronomical Society of the Pacific*, 71 (October, 1959), 421–424.
10. "How Can We Detect Radio Transmission from Distant Planetary Systems?" *Sky and Telescope*, 19 (January, 1960), 140–143.
11. H. Yagoda, "Tracks of Nuclear Particles," *Scientific American*, 194 (May, 1956), 40–47.
12. Murray Gell-Mann and E. P. Rosenbaum, "Elementary Particles," *Scientific American*, 197 (July, 1957), 72–86+.
13. Hans A. Bethe, "What Holds the Nucleus Together?" *Scientific American*, 189 (September, 1953), 58–63.
14. R. E. Peierls, "Models of the Nucleus, *Scientific American*, 200 (January, 1959), 75–80+.
15. *Ibid.*
16. Maria G. Mayer, "The Structure of the Nucleus," *Scientific American*, 184 (March, 1951), 22–26.
17. *Loc. cit.*, p. 36.
18. *Ibid.*, p. 37.

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Problems in Photosynthesis

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The problem-solving method of teaching not only communicates information to students but also teaches them to think.

This paper was presented at the Pennsylvania Round Table of Science Meeting held at Immaculata College, April 11, 1959.

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A few years ago at East Orange, N. J., I had the opportunity to inspect the complete library and laboratory and stock rooms as well as mementos of a truly great American inventor, Thomas A. Edison. The chemical laboratory and the great man's laboratory apron were just as left them when he died in 1931 . . . At the time he was engaged in a project to extract rubber from goldenrod plants. I was amazed at the tremendous variety of materials from all corners of the earth, natural and manufactured products that he had in his stock rooms. Particularly was I impressed by some motto cards tacked in conspicuous places in every room. Each card bore the same quotation from Alexander Pope, an English poet who died before America was born: "There is no extreme to which man will not go to avoid the necessity of thinking." After several years I have probably not quoted the motto in its exact wording, but the meaning is the same. More recently the motto cards have been replaced with the last word in the quotation: THINK.

Today I have arranged some simple equipment that every high school should contain to perform some well-known qualitative tests, roughly qualitative, too, on familiar plant materials. I shall use green leafy plants that typify all those living organisms that are the source of all the oxygen we breathe, all the food and fibers that we consume, and the source of many organic chemicals as they are the basis for the scientific pursuits that are classed as BOTANY.

To begin, let us take a variegated leaf of *Coleus Blumei* that has been exposed to the north light of a window for a few weeks or more, extract its purple pigment with hot water, its green and yellow pigments with hot alcohol. We shall need also some forceps and an aqueous solution of iodine to which a few crystals of potassium iodide have been added. Simultaneously we shall do the same leaf of Coleus that has been kept in a dark closet for four days and another leaf from a plant kept under constant fluorescent lamp with some incandescent light and window light (mixed sources). Three tests at once will require labeling the containers that we shall use:

O—Dark (4 days, Tuesday to Saturday)

D—Daylight in spring (not direct sunlight)

M—Mixed, mostly fluorescent light, continuous

Colored sketches will illustrate the different appearances of the leaves as they are subjected to the various treatments. They will aid me in explaining what I am doing and what happens as I do it.

On removing the leaves from the hot alcohol, most if not all of the green and yellow pigments will have been removed and the leaf will appear white and crisp, like blanched celery. A quick dip in water will make it so flaccid that it must be floated out in a dish with a white bottom or over a filter paper circle that is free from starch or sugar. The iodine is then applied liberally as a test for starch accumulation. We must apply labels to the dishes containing the leaves, so that we can distinguish the source of each leaf. Then we can summarize the results on the blackboard.

What can we conclude?

What does the iodine test indicate?

How can that be proved?

Do all the leaves accumulate starch to the same extent?

What parts of the leaf have no starch in each case?

Can we conclude that the source of light is important?

What would happen if some other kind of plant had been used, for example, an iris leaf, leaves of onions, tulip, daffodil, or some green grass: (We cannot answer the last question until we try the same kind of an experiment.)

What do you believe was the source of the starch in the leaves that give the test for it?

Is there any starch in the water used to keep the plant alive? In the air supplied? In the soil? How can the answers to these questions be determined? What substances are normally or always present in water? In soil? In air?

Now, if we test onion leaves for starch, we find no starch in them. However, if we macerate the leaves in an onion bulb (Onion sets are now available and cheap) or a daffodil, and heat them in Benedict's Solution (1 part) and water (1 part) we can determine that some sugar is present glucose, fructose or invert sugar.

What use is made of all the sugars and starches that may be produced by green plants on this earth?

The Newer Knowledge of Photosynthesis

1. Photosynthesis occurs only in chloroplasts.

2. Water molecules are "split" only in the presence of adequate light into O atoms and H atoms. Some O atoms escape, along with some N atoms and H atoms. At the same time, energy is released.

3. The release of energy may be due either to oxidation or dehydrogenation; perhaps both occur. Many biochemists believe that a compound called ATP (adenosine triphos-

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"The Responsibility of Knowledge"

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This paper was presented at the Pennsylvania Catholic Round Table of Science meeting at Immaculata College, Immaculata, Penna., April 11, 1959.

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As part of the bicentennial Anniversary of Columbia University in 1954, the theme: "Man's Right to Knowledge and the Free Use Thereof"[1] was developed in a series of radio addresses by prominent scholars in various fields. The essays were collected into a paperback edition and the whole project constituted one of the most worth-while advertising ventures ever undertaken. It is regrettable that a greater proportion of the vast sums which we spend annually on advertising (it is more than we spend on education) is not put to such good use. The theme, "Man's Right to Knowledge" has every natural sequel and I hope we do not have to wait another hundred years to witness its development. The sequel entitled "The Responsibility of Knowledge" follows from the ethical principle that every right evokes a corresponding duty or responsibility.

Ethically, it is not difficult to justify man's right to knowledge. It is a consequence of his God-given intellectual capacity and his duty to know God Who is the source of all knowledge. The duties which knowledge entails in those who possess it stem primarily, from the social nature of man. If society has enabled man to acquire knowledge, then man has a duty in justice to make some return.

As men and women travelling along a common road which is lighted by the Spirit of Truth and by the lamp of science, we have, I am sure, often considered the responsibilities of our profession. My only hope then in making the following remarks is that my considerations may have been somewhat different from yours, so that I may flatteringly think as Socrates did in his Apology: "I am that gadfly which God has attached to the state, and all day long and in all places am always fastening upon you, arousing and persuading and reproaching you . . ." (That is why they gave him hemlock.)

It would be wrong of course, to imply, even at a meeting of the Pennsylvania Catholic Round Table of Science, that scientific knowledge is the only kind of knowledge or the only kind that entails responsibility. However, in view of our common interest in scientific disciplines, my remarks on the responsibility of knowledge will fall under three headings:

1. The Scientist's Responsibility to the Professional Community.
2. The Scientist's Responsibility to the Secular Community.
3. The Scientist's Responsibility to the Church.

Responsibility to the Professional Community

In his Novum Organum, Bacon[2] states:—"The true and lawful goal of the sciences is none other than this: that human life be endowed with new discoveries and powers." The key idea in Bacon's definition is *"New Discoveries,"* which implies a severe and rigid search after truth as the first duty of the scientist. The further obligation to communicate his findings to his fellow investigators is a necessary consequence, if the goal of science is to be achieved.

Research appears to be the best way to achieve the goal of the sciences. A minimum contribution would be inventive or creative thought or criticism. From the point of view of the small college, faculty research is a difficult problem, yet the value of such an endeavor as example and stimulus to the student, is well worth the effort and sacrifice. It need not be a splendid or vast effort with administrators, assistants and mammoth equipment. The frontiers of knowledge have been broadened as well by the burette as by the cyclotron. There is no better way to show that knowledge has intrinsic value and inspire a sense of reverence for it, than the example of a teacher-investigator, no matter how small and specialized his field.

A special problem in the scientific community today is that of specialization. After assimilating a score of books, a Greek philosopher could boast of knowing the science of his time. Today, one would have to be a Darwin, Newton and Einstein all rolled into one to even attempt the feat. The rapid progress of science imposes this painful specialization today. It is an inevitable accompaniment of progress, and nowhere is its cruel wastefulness more deeply felt than in the industrial laboratory. The university, where the free interchange of scholarship and the association of teachers and taught is unhampered by utilitarian barriers is our defense against this evil. However, it is a proper duty of all scientists to lower the barriers, by sincere efforts to communicate with related fields and be informed of their progress.

Leaving aside for a moment the fields of science, it has been a personal experience of mine, and I offer this idea for your consideration, that our philosophic training in Catholic colleges is over-specialized. A special terminology and system of thought is a necessary characteristic of every philosophy. But the student who has never been exposed to any other language than that of scholastic philosophy, generally has problems in communicating on philosophic matters with his non-catholic colleagues. While I cherish my own Thomistic training, I believe it would have been more scholarly to have had direct contact with other philosophic systems during this period.

While on the subject of specialists, I might mention, that there is one specialist who used to be exclusive with universities, but has now found his way into industry. He is the absent-minded professor. This was brought home to me by a secretary of a large establishment which employs several hundred Ph.D.'s. She observed a note pinned to the back of one researcher which said: "Don't give me a ride today, I have the car."

Our thoughts on professional responsibility would hardly be complete without some mention of Bacon's Idols: Those false notions which take possession of the human understanding and beset man's minds so that truth can hardly enter. Every scientist must guard against their snares, the capital sins of science so to speak.

The first of these Bacon called the idols of the Tribe. They have their foundation in human nature itself, and the tribe and race of men. They are the false mirror of human understanding which receiving rays irregularly, distorts and discolors the nature of things by mingling its own nature with it. Aside from human affections and faults such as ambitions, vanity and impatience, by far the greatest hindrance and aberration of the human understanding proceeds from the weakness and deceptions of the senses. If the Saints have found it necessary to crucify the passions, to mortify the senses in order to keep their minds in pursuit of the Eternal Truth, should we who seek after its image only, be satisfied with less?

The idols of the Cave are the idols of the individual man. Everyone has his own cave or den which refracts or discolors the light of nature. In modern language, we are children of our environment and must constantly fight the marks of our education, our readings and the authority of those we esteem. "Tell me whom you frequent and I will tell you what you are!"

Finally, there are idols formed by the intercourse and association of men with each other which Bacon calls the idols of the Market-place. These are the ill and unfit words which wonderfully obstruct understanding. They lead men away into empty controversies and idle fancies. Within the bounds of this worship, one can discuss the whole problem of semantics and communication in the field of science or the need for accurate reporting and perhaps once again, a common language for scholars. What a pity that Latin was allowed to lose its place of eminence.

Responsibility to Society

To preface my remarks on the scientist's responsibility to society, I want to recall a little anecdote which went the rounds a year or so ago, when the public became aware of those little pills called tranquilizers. A certain woman had a young daughter who brought her no end of anxiety. A neurotic condition caused the daughter to want everything she laid eyes on. (Of course, this is not uncommon, since most children today are frustrated if they do not start life in a "womb with a view.") The mother took the daughter to a psychiatrist who prescribed some tranquilizers, and also recommended them for the mother. A few weeks later, the doctor decided to check on his patient, and calling the woman on the telephone, asked how her daughter was getting along? "Daughter?" replied the mother, "what daughter?"

In this little modern day parable one could imagine the mother to represent society and her daughter, the scientific community. Many a time in the last decade society has wished for a tranquilizer pill which would allow her to forget that science and scientists existed. Scientists have frequently been accused of being soulless and amoral, (and of course, egg-heads), for their alleged indifference to the use to which their inventions are put. In short, scientists are blamed by many for contributing to the horrors of modern war and equipping society with powers for which it was not morally ready. These charges have been answered by many eminent men of science, and I quote the following from Professor E. Bright Wilson's thoughtful book: "An Introduction to Scientific Research."[3]

> "It is practically impossible for the pure scientist to predict the moral consequences of his choice of a problem, however much he may wish to do so. The wisest man living cannot foresee all the future effects of a new basic discovery and correctly balance the good uses against the bad. It is hard for non-scientists to believe this but very important that they should be repeatedly shown the evidence which supports it. Even after the fact, who would be bold enough to say that the study of radioactivity should never have been begun? Even aside from the atom bomb, it is impossible to untangle its influence on today's life, but it certainly had a strong effect on theories of atomic structure, chemistry, genetics, electronics, astrophysics, and geology. In fact, like so many other fundamental discoveries, it is mixed into every branch of science today and therefore into every branch of technology . . . Let those who decry science come out into the open and say that they prefer ignorance to understanding, darkness to light."

I find myself very grateful to Professor Wilson for these thoughts. The true dignity of science is the speculative knowledge that it gives, apart from the uses to which this knowledge is put. As Newman[4] said: "Knowledge is its own end." In short, it is a *Good*. The responsibility of the scientist to society is fulfilled by his steadfast and honest pursuit of this good. One can have little sympathy for the contention that he should foresee every evil use that anyone might make of a particular discovery and refrain from making it.

The teaching responsibility is probably the most obvious social responsibility of the scientist. Of all citizens, he should have special concern that those who leave our schools have a general understanding of what science is, and the part it plays in the world in which they have to live. It was Mathew Arnold who said: "Culture is a knowledge of the best that has been said and done." Today, this must include some scientific knowledge. Science teaching is no longer simply a matter of equipping the school-leaver for some particular vocation, it is part and parcel of a liberal education. For, the citizen today is rubbing shoulders continually with science and cannot make the decisions required of a free-man without some knowledge in this field.

Merely to enumerate some of the major topics which occupy congressional deliberations, would demonstrate the extent to which wise political decisions for instance, turn on an understanding of scientific and technical issues. Such matters as road-building, air pollution, and radioactive fall-out, require more than a jurist's mind. And, unfortunately, the juridical mind rather than the enquiring mind has been the main product of Catholic education. This has come about very simply because of overemphasis in our Universities, on salvation rather than scholarship. Now I am not saying that the former is less important than the latter. But it must be remembered that the discovery of truth is to the glory of God and it is the real purpose of the University.

As Christians, we may ask also, if our idea of society

should not be without national boundaries? The teaching obligation of the scientist would then carry to those less fortunate countries who have not yet realized the countless beneficent applications of science, because of their deficiency in basic knowledge. The efforts of our missionaries and our foreign programs are a source of pride to all of us, but there is here a real opportunity for lay apostolate. Sabbatical years or teaching apprenticeships spent in the secular universities of many Eastern countries, would do much for them and for ourselves also.

So far we have not touched on the duties of the scientist to contribute to the material welfare of the community. That he has not been remiss in this respect is quite evident every time we turn on a radio or swallow a sulfa pill. Our society has its own system, sometimes too efficient, of channeling the efforts of its scientists into applied fields. The efficiency of this system in providing for the basic needs of the people (and even creating some), has been amply proven. Today the need is for men who can resist the lures and social pleasures to travel the road to immediate practical knowledge, rather than one where the end is not in sight. The basic needs of a society being satisfied, there should be no compunction for university personnel to travel any other but the latter road. The history of science furnishes abundant evidence that a scientist usually serves his fellow-men better by extending the boundaries of knowledge than by aiming at some social result. Compare the impact of Lavoisier's work in chemistry with that of several centuries of alchemists. Penicillin was not discovered by a bedside physician.

Responsibility to the Church

We come now to the third part of our theme, viz. The Responsibility of the Scientist to the Church. To non-Catholics who are cultivators of the sciences, such a consideration may appear as a distinct limitation on the Catholic scientist's ability to attain truth. They argue that religion being based on Revelation, should have no authority over truth which is reached by the light of pure reason. We answer as Newman[4] did, that: "Truth cannot be contrary to truth," and he who believes Revelation with an unshakeable faith, cannot segregate in his mind the supernatural and natural truth. The two must not only coexist in the mind of the Catholic scientist, but they should be in the most perfect harmony which is to be expected of two beings which share a common designation. To achieve this state, it is important that the scientist have a clear understanding of what the practical interrelation of these two forms of truth should be. In God, they exist as one truth; in man, the limitation of the human intellect does not allow this perfect unity; they must coexist.

The conditions for this coexistence of natural and supernatural knowledge have been the source of endless controversies. In our struggle for a clear definition of these condtions of coexistence, which are so important to the life of the scholar and the vitality of the Church, it is helpful to look at the history of the Church-Science relation. For God is working through history, and the whole of history is an unfolding of the Divine plan. Thus a study of history can help us to know God and to know ourselves, and thereby to better define our objectives in life.

If we consider Western Europe during the so-called "Dark Ages," we note first of all, that the Church was the center of intellectual life. Her outlook on knowledge at this time is directed and defined by some of the Fathers and Doctors of the Church. In his works written at the end of the fourth and the beginning of the fifth century, St. Augustine emphasizes the primacy of faith with his "Nisi crederetis, non intelligetis" i.e., it is through faith in the scriptures that one can attain to knowledge. (If you do not believe, you will not understand.) But to understand in the sense of Augustine does not mean to observe and penetrate the exterior world, for he thinks like the neoplatonists, in terms of universal ideas which he places near or in God. The modern scientists would have felt even less at home in this environment than did the Mannicheans, a heretical set who believed in the primacy of reason and who were victims of Augustine's genius.

The struggle between reason and faith flared up once more in the first half of the twelfth century in the person of Breton Abelard, who was more "sinned against than sinning." He was the brightest light in a period which saw a revival of logic. During this period some Masters spent their energies debating whether: "When a pork is brought to market, is it the man or the rope which holds him?" (This question was considered unsolvable) and the Sophists came into their own again with such things as: "You have what you have not lost, you have not lost horns—hence you have horns." Abelard was one who knew how to make a better use of his reason. He devoted himself to reconciling through a purely logical method, propositions of the Fathers which were apparently contradictory. His position was—when we doubt we enquire, when we enquire we know. He never doubted the Church's authority, though he was condemned by her because the time was not ripe for any kind of doubting no matter how well intentioned. Nevertheless, Abelard and his disciples had set the stage for St. Thomas, and contributed a method which was a much better instrument of learning, particularly for the scientists who were to follow.

Even with the first budding of science in the persons of Robert Grosseteste (who died as Bishop of Lincoln in 1253) and the Franciscan Roger Bacon, we still find a nervous and non-tolerant attitude. Bacon's views met with repressive measures and he was imprisoned in 1278. The stage of science had been set, however, for these men who were basically scholastic philosophers, taught that: neither the testimony of the ancients nor any logical deduction could give satisfactory answer to the questions which were set concerning the universe; one had to begin with observation of the particular facts; recourse to mathematics could then lead to explanation; but these were worth nothing unless confirmed by experiment.

Time does not permit us to follow too carefully this interplay of science and theology up to the humanist movement in the 15th century. Suffice it to say that the principal fault of the middle ages, was that all knowledge was directed to the immediate triumph of faith. This eventually led to controversies wherein science was involved in matters not strictly scientific and the Church in affairs outside the province of religion.

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Philosophical Aspects of Evolution II "The Abstract Character of Science"

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In our March issue Doctor van Melsen discussed the scientific problem of the phenomena of life, and the philosophical problem of creation. In this issue he discusses the distinction between inanimate and animate matter.

This article is from a paper presented at the Duquesne University Symposium on Evolution, April 4, 1959.

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To say that the phenomena of life can be explained by physics and chemistry seems tantamount to denying the distinction between inanimate and animate nature. Yet, a more thorough analysis will show us that there is a great distinction between the two problems and it will also throw a new light on the dispute between mechanicism and vitalism.

Any dispute needs a common ground, a common assumption, a common frame of reference without which the dispute would lose its sense. Mechanicism and vitalism had in common the assumption that, in principle, physics and chemistry are capable of giving a complete understanding of the inanimate material world. They argued about the question whether or not these sciences could fully explain also the animate world.

Mechanicism was convinced that they could, and vitalism that they could not. According to the latter, there was a mystery of life, unattainable by science. Both mechanicism and vitalism agreed, therefore, that if the phenomena of life could be explained by chemistry and physics, the whole mystery of life would be solved, for life would be reduced to purely material principles without any mystery.

The mistake in this line of thought lies in the starting-point—namely, the assumption that physics and chemistry adequately explain inanimate nature (for this very reason the inanimate world is often called the physico-chemical world). The assumption, however, is wrong in two ways. For the object of physics and chemistry is, on the one hand, broader than the inanimate world and, on the other, more limited. Physics and chemistry are abstract sciences, which means that their object is not the material world in its full concreteness, but only certain aspects of that world. On the one hand, their object is therefore not limited to inanimate nature, but animate nature belongs to it also regardless of the problem whether or not there is an essential distinction between them. On the other hand, even the inanimate world can never be fully explained by physics and chemistry. The correct evaluation of the status of physics and chemistry as abstract sciences is, therefore, of the greatest importance for the understanding of the dispute between mechanicism and vitalism.

Vitalism was not mistaken when it asserted that there is a mystery of life, but it was wrong in the assumption it had in common with mechanicism that there is no mystery involved in inanimate matter.

Mechanicism was not wrong in so far as it claimed that the phenomena of life could be studied and explained by the same methods as the phenomena of inanimate matter, but it was wrong only in so far as it thought that, consequently, no mystery was involved in animate matter.

To put it another way, if mechanicism will be proved right in assuming that abiogenesis is possible, then this does not mean that vitalistic biologists are wrong in speaking about the mystery of organic life, but will show only how great the mystery of the material world is. A better understanding of this fundamental truth, which is a consequence of the fact that physics and chemistry are abstract sciences, would contribute much to the clarification of many philosophical disputes concerning abiogenesis and evolution, and especially that of the descent of man from lower forms of life. In the following we will, therefore, focus our attention on the problems of the distinction between inanimate and animate matter. It will give us the opportunity to discuss at the same time the distinction between man and animal. For it is clear that, philosophically speaking, the real problems of evolution concern not so much the transition of one form of animal-life or plant-life to another as the transition from inanimate matter to animate and from animal to man.

The Distinction Between Inanimate Nature, Animate Nature, and Man

In our natural attitude with respect to the great realms of nature—inanimate matter, vegetative and animal life, and finally man—we usually think of an hierarchic order in which the higher rank possesses everything pertaining to the lower plus something specific proper to the higher rank. This way of thinking is reflected in our manner of speaking. We say, for example, that the inanimate material world does not *live*, and that it does not have any sense or intellectual knowledge, but merely *exists* with its material properties. As a consequence, when we speak about the level of plant-life, *life* is added as something special to mere material being, a plant has something, *life*, which a material thing does not have. By the same token an animal has something not found in a plant—namely sense-knowledge, and a human being has superadded to all this his intellectual knowledge. Intellectual knowledge and life are thus considered extras, special features added to material structures, which in themselves already existed as complete entities.

As a result of this way of thinking, we make a clear-cut distinction between a non-living object and a living being. Non-living and living are contradictory terms. Something is living or it is non-living; it is living when it is in possession of that extra which we call life, otherwise it is

non-living. There is no third possibility. The extra feature, life is present or not.

The same kind of clear-cut distinction is made between man and animal. Man is an animal which is in possession of something very special—reason, a spiritual faculty. This spiritual faculty is considered as totally different from anything else found in matter. When asked what we mean by spiritual, we are inclined to answer that spiritual means non-material, whereas material means non-spiritual. Material and spiritual are, therefore, considered contradictory terms in the same manner as living and non-living.

I would not go so far as to say that this way of logically handling such terms as living and non-living, material and spiritual, is entirely wrong. On the contrary, there are too many sound reasons for it, but this does not mean that there is nothing wrong with it.

Let us begin with the distinction between material and spiritual. First of all, it may be remarked that there is a peculiar inconsistency between the way we experience the presence of the spiritual and the way we evaluate that experience in the logical order. We experience the spiritual exclusively in man, that is to say in a material structure and not in any dualistic way. The spiritual faculties of man are strongly interwoven with his material structure.

Whatever reasons we may have for opposing matter and spirit, they should never seduce us to oppose them in such a way that their actual unity in man becomes impossible. There is some truth in the saying that if man had not existed, philosophers would have declared his existence impossible. It shows the danger of reflection going wrong. There are, of course, very good reasons for opposing matter and spirit. Plato and Descartes were no fools. In reflecting upon his intellectual knowledge, man experiences the spiritual character of this knowledge. His concepts are abstract and universal and as such beyond the limitations of time and space that are typical of matter. Even concepts of material things, for example, the concepts of colors, which lose their content when there is no actual connection with the material sense-representation, are nevertheless not tied to just one particular instance. Even they are universal.

Much more important, however, for the spiritual character of his intellectual knowledge is that man is conscious of the abstractness of his concepts and is aware also of the limitations of his knowledge. Reflecting upon his intellectual knowledge, he discovers its typical limitation. In realizing his limitations man is, in principle, beyond any limitation. Because he is capable of evaluating his situation as limited, as bound to matter, he is at the same time above his situation, and that is exactly what we call spiritual. We try to express by this term the "openness," "freedom," and "self-presence" of the spirit, as contrasted with the closedness and lack of freedom of matter. Thus spiritual seems the exact opposite of material. The logical consequence of this line of thought seems to be a dualistic conception of man. Yet, if we study man as we experience him, we don't find this consequence of our reflection to be true, for man is a unity, a unity of matter and spirit. If this unity seems impossible, then something must be wrong with our concepts. In one way or another, any anthropology will have to acknowledge the basic fact of man's unity.

Of course, that unity is not a monistic unit. Monism, be it materialistic or spiritualistic, does not help us any further. Matter is not spirit, anl spirit is not matter, yet both are unity. St. Thomas has given a sharp formulation of the problem when he stated that the *anima*, the human soul, was both *form of the body* and a *subsistent* spiritual being. It is a formulation which balances on the edge of contradiction. Yet I think it is the best formulation ever given.

It would be a flagrant contradiction if matter and spirit were the contradictory entities, which our way of using the terms matter and spirit suggests.

The fact of man's unity, however, shows beyond any doubt that this suggestion is wrong. The relation between matter and spirit can never be one of mutual exclusion. What then is that relation?

Above we have seen that neither biological life nor intellectual life should be conceived as external additions to material being, but as an internal unfolding or explicitation of material being. To live is the mode of *being* of an animal, as intellectual life is the mode of being of man. We can put it in another way: Matter, as such, is a reduced mode of being because it is devoid of intellectual knowledge and of organic life. There is, so to speak, a proportion between the degree of knowledge a being possesses and its degree of being. It exists only in so far as it is capable of knowing. That is the consequence of what we have said—namely, that the cognitive faculty is not an addition to matter, but an internal unfolding of its very essence. But is that consequence not absurd? Does it not inevitably lead to the conclusion either that matter does not exist at all or that all matter is endowed with cognitive faculties? The dilemma does not seem very pleasant, for both conclusions seem contrary to reality. Matter does exist and it does not even show the faintest trace of knowledge. Knowledge in its lowest form is sense-knowledge and this knowledge is a property of the higher forms of life, perhaps even of all life, but certainly not of matter as such. It is interesting to note that biologists don't agree on what level of animate nature sense-knowledge is to be assumed. The first traces of it can probably be found with plant-life, but they are not certain. In animate nature sense-knowledge appears as a faculty which gradually takes form and unfolds. This fact confirms to a certain extent the general line of thought we are following. Yet, we need more confirmation than is given by mere speculative extrapolation beyond the realm of life; we need in material activity itself something that although it certainly is not knowledge, can properly be brought in connection with it. Let us try to find this connection. It is not too difficult.

First of all, it should be remarked that matter is knowable. By being knowable, matter, therefore, is not foreign to knowledge. Of course, being knowable is something passive and, therefore, quite different from having an active cognitive faculty. And it is precisely by his active faculty of intellectual knowledge, of self-presence, that man distinguishes himself essentially from a material being. Yet—and this is the point at issue—the distinctive moment is not something that is utterly foreign to matter. For in the cognitive act the knowing subject and the known object are one. Both contribute to that unity. It would be a mistake to evaluate the contribution of the known object

merely as a passive potency, for matter makes itself known by its material activities. These activities are a kind of self-expression of matter. It is by that self-expression that matter answers the questions which the scientist asks in his experiment. Of course this answering, this self-expression is more passive than active, because it is wholly determined by nature; matter undergoes its own activity more than it exercises it, yet there is something active too. Not for nothing do we speak of material *activity*. In its activity a material thing "knows" how to act, how to react, because it is inscribed in its nature, and by that very activity it makes itself known to man. Perhaps the best way to state the relationship between material activity as self-expression of material being and the intellectual knowledge of man would be as follows. Although there is no cognitive faculty in matter, yet the passive role matter has in the process of knowing is not entirely passive, there is something active involved too. On the level of material being something can be found that corresponds to the cognitive faculty of man. It is more passive than active, but exactly the same applies to the level of *being* of matter, for material being in a sense is also both active and passive.

We are, therefore, entitled to the conclusion that there is a proportion between the degree of knowledge a being possesses and its degree of being. We may even go so far as to say that a being exists only in so far as it is capable of knowing, on condition that we are aware of the analogous way the term *knowing* has to be understood. Or to put it another way, the higher forms of existence in nature (plants, animals, and man) are not higher forms because of the addition to matter of entirely new principles or factors, they are higher forms because of the unfolding of something already present in matter.[8] Does this mean that the distinctions between inanimate nature, animate nature, and man are only gradual and not essential? Are we not forced to a monistic conception of man? No, we are not, for to state an analogy does not mean to state a similarity. Let us elucidate this point.

To begin with, it should be recalled that the main philosophical problems connected with the dispute around vitalism, evolution, and the unity of man find their origin in the way we define such pair of terms as non-living and living, matter and spirit. The tendency exists to define them in a mutually exclusive way. Consequently, spiritual means non-material, material means non-spiritual; they are contradictory terms like non-living and living. This way of defining is the result of our schematizing way of thinking. We have to correct this way as we have done above, but human knowledge being what it is, we are never able to correct our schematizing way of thinking in such a manner that we are beyond any schematization. The only manner of correction open to us is to counterbalance one way of schematizing by another.

Consequently, when we speak of a gradual unfolding of material being to characterize the status of animate nature and of man, we should not forget that this way of speaking is schematic too. In order to understand nature we must use both ways of schematizing, the one that speaks of gradual unfolding and the other that speaks of the addition of entirely new factors. For nature itself shows us both aspects. On the one hand, it shows graduations and never sharp distinctions. The biologist hesitates whether a virus should be considered as living or as non-living, and he can find no clear-cut distinction between vegetative and sensitive life. By the same token human babies do not show much of intellectual life, they are just young animals. On the other hand, the fact that abiogenesis and macro-evolution, if possible at all, do not belong to the normal course of events in nature clearly indicates what important and essential thresholds must be crossed by the transition from non-living to living matter can by the development of one form of life into another. The same applies to the gradual unfolding of the cognitive faculty. With man this faculty has a status which is essentially different from what we have called the degree of knowledge proper to matter. Yet, there is an analogy. The cognitive faculty is not an entirely new factor.

Evolution and Finality

It is a matter not devoid of interest to note that so far our reflections on the different status of being, proper to inanimate and animate nature and to man, did not say anything specific about evolution. Their only purpose was to point out how intimate the relations are between the different levels in nature, and how we have to consider these relations as a gradual unfolding of being. But this point of view neither proves nor disproves evolution. Needless to say, however, that this does not mean that our philosophical reflections were superfluous or irrelevant. For, although it is not the task of philosophy to prove or disprove evolution, philosophical arguments are as a matter of fact used in the discussions of evolution, and for this reason they have to be examined in order to know in what way they affect the theory of evolution.

This theory takes the line that all forms of life not only are related to one another, but that they descend from an original primitive form of life which itself has developed from non-living matter. In one word, the theory of evolution considers the general relationship between the different forms of life as *kinship*. Whether or not this is true, only biology and biochemistry can decide, and not philosophy. We have seen, however, that the problem involved is not easy to decide on account of the peculiar nature of the problem which has not only a scientific, but also an "historical" aspect. The historical data are by their very nature scarce, there is not enough to go on, and much has to be extrapolated. In such a situation proponents of the various possible viewpoints look for all kinds of arguments to bolster their respective opinions. So it was quite natural that some adherents of evolution who did not believe in creation, found in this dislike the strongest support to their doctrine —it seemed the only way out. It was quite natural too that on the rebound, some who did believe in creation, did not believe in evolution. In their opinion the data were too scarce to go on and they searched for philosophical arguments to oppose the idea of evolution. For this reason the nineteenth century controversy about evolution gives the impression that the main dispute was philosophical. The scientific data seemed to be relevant only in so far as they endorsed or weakened the philosophical positions. Yet Lamarck and Darwin had formulated an interesting biological problem, and although in their time that problem could not be solved, the problem did stir the minds of the

biologists, and they started to work on it and gradually they found more and more evidence for certain solutions or possible solutions of the problem on purely scientific grounds.

As a result there has been an evolution of the theory of evolution, that is to say there has been an historical development of the problem of evolution. Formerly the problem was tied up with all kind of philosophical considerations, now it is a problem in its own right.

Such a development is the normal course of events. Atomism, for example, also was first a philosophical doctrine, albeit one with a scientific aspect. The latter aspect gradually developed, slowly before the seventeenth century, rapidly thereafter.[4] Philosophy and science are both the result of one and the same original quest of knowledge. In the beginning of the rational career of man we find therefore that philosophical and scientific aspects of knowledge were strongly interwoven. Philosophical and scientific problems were still confused and not clearly distinguished. Man hardly even knew that they were distinct problems to be solved by different methods. Only in the practice of research did the necessity of differentiating methods and problems reveal itself, and only reluctantly man resigned himself to specialism in science. For this reason it is easily understood that again and again, with each new problem arising in the course of history, the different aspects were not clearly distinguished from the beginning, but had to be found while working on the problem. We have seen the same kind of development in the dispute around vitalism and mechanicism. We have seen there, too that the solution of the scientific problems does not automatically solve the philosophical issue. The solution of the former does throw important light on the latter, but the philosophical problem whether or not a living being has a higher status, has to be considered on its own merits as a philosophical problem. Since we have considered this philosophical problem, let us examine now what light it throws on the different philosophical questions which in the past were rightly or wrongly connected with the theory of evolution.

The main question to which all other problems can be reduced is whether evolution does not reduce the appearance of higher forms of life, especially of man, to chance-events. It seems as if the driving forces of evolution are entirely blind and, consequently, everything that appears in the course of evolution would be the result of mere chance. This idea seduced many opponents of evolution to use the theory of probabilities in refutation of evolution. They argued that according to that theory the probability that a complicated organism came into existence by chance must be calculated as zero.[5] As a matter of fact, however, this kind of calculations is pure nonsense for the simple reason that we do not know enough about the natural affinities of molecules to form higher structures to have a serious basis for these calculations. The stability of a living organism demonstrates that molecules have such affinities. Therefore, if abiogenesis has taken place, chance may have played a role, but certainly not the most important one. The most important factor must have been the natural affinity of molecules to form higher structures in certain circumstances. Consequently, if biochemists try to trace the course which abiogenesis has taken, they think in terms of stabilities of structures, tendencies to form more complicated structures, etc.[6] In other words, they try to discover what real potencies molecules have and in what circumstances these potencies will be actualized.

By the same token if evolutionists speak about random-distribution of mutations, this does not mean that evolution is just a chance-event. For which mutations are favorable depends upon their usefulness. The whole discussion around finality in evolution has been confused, because the analogy of the concept "finality" has been neglected.[7]

We have seen above the material activity is a kind of passive activity without self-knowledge. For this reason an evolution from molecules to macro-molecular structures and eventually to living organism is not directed toward a known aim, and in this sense there is no finality. It is, however, an evolution based upon the nature of matter, upon its immanent properties. The course the evolution actually has taken may have been arbitrary and irregular, yet the very existence of the different forms of life show how these forms are the natural results of the material potencies. Since the finality which each form of life exhibits, is based upon the inherent tendencies of its material constituents, the finality of the evolutionary process as a whole is based upon these tendencies too. Finality does not mean that an entelechy works differently from the blind potencies of matter itself, but that the mystery of life is an unfolding of the mystery of material being.

But now a new problem arises. Is it not a consequence of the line of thought we are following that man too has to be considered the product of the working of these blind tendencies? The answer has to be in the affirmative. What else should he expect? For, even apart from the theory of evolution, is it clear that all spiritual activity of man is based upon material structures. The matter-spirit problem is not easy to solve, but it is by no means a problem raised by the doctrine of evolution. The problem already existed and evolution has made it only more acute, because it has given an "historical" aspect to an old ontological problem. Some evolutionists suggested that the historical aspect solved the ontological problem, too. The mistake is obvious as we have seen. Evolution offers a possible explanation of the unity of the material world, but it does not explain that world as such, nor the hierarchy of beings in it. It should be clear that when the theory of evolution speaks of man as the product of the working of blind material forces, this thesis has to be taken in the abstract sense in which the theory of evolution considers man.

It does not deny, therefore, the essential difference between man and the rest of nature, no more than the physico-chemical explanation of an organism denies the difference between a living organism and an inorganic thing. Evolution does not explain man, because by its physico-chemical and biological means it can never explain the spiritual in man, nor the meaning of the material universe and of its inherent tendencies. The best science can do—and this in itself is of the highest importance—is to examine what material structures condition the spiritual life. The scientist can do this, because science itself is a spiritual activity, it is part of the spiritual effort of man to understand himself. For man can never be what he is destined

(*Continued on Page 62*)

Low Frequency Waves From Sunset Canyon

FROM THE NATIONAL BUREAU OF STANDARDS, UNITED STATES DEPARTMENT OF COMMERCE, WASHINGTON, D. C.

Boulder, Colorado—From a picturesque valley in the Rocky Mountains, radio waves now carry the world's most accurate yardstick of radio frequency for thousands of miles across the globe—and do this a hundred times better than this standard has ever been broadcast before—according to an announcement today by the National Bureau of Standards.

Broadcasting began today from Sunset Canyon, about twenty miles west of Boulder. Transmission is on the very low frequency of 20 kilocycles. (The lowest frequencies picked up by a home radio are about 560 kilocycles.) Within their range these signals will substantially increace the accuracy of the NBS standard frequency broadcasts because low frequencies travel quite differently from ordinary radio waves.

Signals from the Sunset Canyon station (call letters WWVL) may reach as far as Hawaii—maybe even to New Zealand—but they are not strong enough to provide good coverage over the entire globe. The Sunset station, however, is only the first step toward eventually providing world-wide broadcasts.

Both time signals and the national standard of frequency are currently transmitted on a world-wide basis by two short-wave stations belonging to the National Bureau of Standards, WWV at Beltsville, Maryland, and WWVH on Maui, Hawaii.

These signals, like the radio waves received by a home radio, bounce between the earth and the upper atmosphere (ionosphere) to reach the receiver. But the height and density of the ionosphere changes constantly and this creates small, erratic changes in the speed of these radio waves.

Errors introduced by these changes were insignificant ten years ago. Today, however, it is increasingly important to measure both time and frequency with greater and greater precision: to coordinate the recordings of tracking stations for missiles and satellites, to measure minute quantities of electrical and radio energy in areas of basic research, and to permit development in the field of electronics (where a standard of radio frequency is as indispensable as a micrometer in the machine shop).

The low-frequency waves from Sunset Canyon will follow the curvature of the earth with the ionosphere and the ground acting as upper and lower limits of a gigantic duct to guide the signals over the globe. Since the ionosphere will thus serve only as a boundary—not a direct reflector—it will have almost no effect on the speed of the waves. For this reason the 20 kilocycle frequency will provide a much more stable transmission than the short-wave frequencies of WWV and WWVH.

The Sunset station is the result of several years of effort and several more years will be required before a true global transmitter is on the air.

Many investigations, by such men as J. A. Pierce, at Harvard, have shown that very low frequencies can transmit standard signals over long distances with great accuracy. A study in 1958 by two scientists at the NBS Boulder Laboratories, A. D. Watt and R. W. Plush, indicated that the 20 kilocycle frequency was the most efficient to transmit a standard frequency on a global basis. Radio waves, however, are not bound by international boundaries and use of the different frequencies must be approved by both national and international organizations.

In January of 1959 NBS recommended that the 20 kilocycle frequency be adopted by the U. S. group of the International Consultative Radio Committee (CCIR). CCIR adopted the proposal in April 1959 and in December of 1959 the International Radio Conference at Geneva, Switzerland, adopted the 20 kilocycle standard frequency band for the International Telecommunications Union.

In January of this year the U. S. Government's Interdepartmental Radio Advisory Committee (IRAC) approved a National Bureau of Standards application to operate a 20 kilocycle standard frequency broadcast and this new service was registered with the I.T.U. This automatically placed a deadline into effect as international agreements specify that a valid registration requires a station to be in operation within ninety days after the application is approved. Technically it is vitally important that the United States and NBS start operating at this frequency as it provides a means for the distribution of standard frequency with high precision over great distances.

To meet this deadline—and to rapidly and economically provide a better frequency standard for as large an area as possible—the National Bureau of Standards has modified an existing antenna in the Rocky Mountains.

The antenna is a copper-coated steel cable stretching more than half a mile across the top of Sunset Canyon. From the center of this another cable was dropped to transmitters at the canyon floor. This forms what radio engineers call a top-loaded antenna with the canyon walls acting as giant supports to hold the cables above ground. The tremendous size is necessary because of the great length of a 20 kilocycle radio wave (each wave is almost ten miles long while television waves, by comparison, range from about 1 to 16 feet).

Currently, users of WWV can, in a few hours, use the short wave signals to measure frequency to a few parts in ten million. Users within the range of the WWVL Sunset station (several thousand miles) will be able to make measurements a hundred times better—to one part in 10 thousand million.

The knowledge and ability which has resulted in the Sunset antenna has involved all four Radio divisions at the Boulder Laboratories of the National Bureau of Standards. This includes determining the best frequency, obtaining the site, and adapting existing transmitters to do the job. Prime responsibility, however, for the standard broadcasts and for developing the Sunset installation lies with the Radio Standards Division headed by W. D. George. In this group the major workload has been shared by W. W. Brown,

(*Continued from Page 50*)

UNITRON student microscopes offer

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The UNITRON Student Auto-Illumination Microscope, Model MSA, employs a newly designed stand in which all components and controls are within easy reach. The inclined eyepiece tube allows comfortable posture and may be turned in any optional observing direction to permit two students sitting side by side to share a single instrument. With the built-in illuminating system of the superior low-voltage type, each student is assured of the correct lighting. The transformer is conveniently housed in the microscope base itself where it contributes to the stability of the stand rather than to the clutter of the laboratory table.

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Low Frequency Waves

(*Continued from Page 47*)

A. H. Morgan, D. H. Andrews, and men working under their direction.

Initially the 20 kilocycle signal will only serve as a frequency standard. Before the signal can be used to measure time intervals, such as a millionth of a second, new equipment must be built that will modulate the signal so that a particular wave can be identified at both the transmitter and the receiver. This is more difficult at very low frequencies because of the length of the waves involved.

The original signal will be used primarily by research organizations in studies to prepare for the eventual world-wide transmitter.

Within a year it is planned that a pilot station (for the global transmitter) will be built on the plains of Colorado and the Sunset equipment will be transferred to the pilot site. The pilot station will be much more effective (both because it will be on the plains and will have higher power) but it requires building tall towers to support the antennas. In addition to the 20 kilocycle signal the pilot station will also transmit a strong 60 kilocycle signal.

To meet as many needs as possible for a better frequency standard within the United States, the Boulder Laboratories of the National Bureau of Standards began broadcasting experimental, low power, 60 kilocycle signals in 1956. Because of their low power these signals are not well received at distant points and their use is limited. More than fifty organizations, however, from coast to coast have been using the signals during the past two years and have obtained from ten to a thousand times better precision than they received from the short wave broadcasts. Because of the reliability and accuracy of these signals some organizations have been able to cancel plans for installing expensive atomic frequency standards within their own laboratories.

Both the 60 kilocycle signals and the short wave broadcasts will continue even after the global 20 kilocycle transmitter is put in operation. The global station will provide standard time interval and frequency signals which will be accurate anywhere in the world to a few parts in 10 thousand million for measurements made in a short period and will thus serve U. S. possessions and bases overseas. The 60 kilocycle broadcast, however—when its power is increased—should provide even better service within the United States (accuracies to a part in 100 thousand million). It is also relatively easy to modulate the 60 kilocycle signals but this frequency is too high to be particularly effective beyond the continental limits of the United States.

The range and accuracy of the 20 and 60 kilocycle signals are critically needed by such groups as the U. S. Air Force, the National Aeronautics and Space Administration, the Atlantic, Pacific, and White Sands Missile Ranges, and the Smithsonian Institute (for Satellite tracking). The special receivers, however, which are required to pick up these low frequency broadcasts cost several thousand dollars.

This is the reason the short wave broadcasts will always be of value. They require only the simplest receivers and their accuracy is sufficient to meet the current needs of television and radio stations, electric power companies, amateurs, smaller businesses, and the general public.

In fact, the WWVH broadcasts from Maui should be improved by the initial Sunset transmissions. If the Sunset signal extends to Hawaii, as expected, it will be used to control the WWVH transmissions and thus increase their accuracy from ten to a hundred fold.

BACKGROUND INFORMATION ON 20 kc SUNSET TRANSMISSION

20 kc Transmission of WWVL

The Sunset installation will use a 20 kw transmitter which should provide coverage as far as Alaska and Hawaii with a measurable accuracy by users which approaches one part in 10^{10} for observing periods of about one hour.

The antenna which is being adapted for this transmission has previously been used for low frequency ionospheric research, whistlers, and VLF emissions. It consists of a copper-coated steel cable stretching 3,400 feet from end to end with a center drop of 900 feet to the canyon floor.

Before the 20 kc signal can be used to provide a time reference a means must be provided of identifying a given cycle at both the transmitter and the receiver. Research is being conducted by NBS to determine the best methods of cycle identification and time signal modulation.

The Sunset signal will be primarily used in studies which will help prepare for the eventual 300 kw transmission. These will include attenuation, phase stability, modulation for time signal distribution, and receiving techniques such as design and how the receiver might best be employed.

The eventual global transmitter should be of particular value to international users, the National Aeronautics and Space Administration, and world wide military bases and missile ranges. It is estimated that the number of such users will exceed 500 within five years after activation. Receivers for this transmission will be moderately complex, and including a clock might cost $3,000 in small production quantities.

High frequency standard broadcasts of WWV and WWVH:

These are generally limited in accuracy to about 1 part in 10^7 because of progressive movements of the ionosphere. Measurements over a thirty-day period can extend this to a few parts in 10^{10} but very expensive laboratory equipment is required.

Yet as early as 1954 many frequency standards were in operation with stabilities of a few parts in 10^8 per month and quartz resonators were being adjusted in production for stabilities of better than 1 part in 10^{10}. To help meet these needs the 60 kc transmission was begun in 1956 (see below).

The HF signals are being retained, however, for they should always meet the needs of more than a half million firms and individuals.

The Sunset transmission will be used to control the WWVH (Maui, Hawaii) broadcasts and will increase their transmitted accuracy by two or more orders of magnitude.

60 kc transmission of WWVB

An experimental low-power 60 kc broadcast was begun in 1956 at Boulder, Colorado, with an antenna input of 2 kw.

(*Continued on Page 63*)

Foundation Invites Proposals for Summer Conferences for College Science and Mathematics Teachers

The National Science Foundation announced today that it will continue to support in 1960 an experimental program of some 20 Summer Conferences designed pirmarily for college teachers of engineering, science, and mathematics. The Summer Conferences are of shorter duration than, but generally similar to, the Summer Institutes which the Foundation has successfully supported in recent years.

Colleges and universities interested in sponsoring such conferences are invited to request further information from the Program Director for Summer Institutes, National Science Foundation, Washington 25, D. C. The deadline for submitting proposals is December 15, 1959.

Although planned and directed by the Nation's institutions of higher education, Summer Conferences are supported by Foundation funds to defray direct operational costs plus expenses of participants. Summer Institutes, 362 of which were supported by the Foundation in 1959, are usually from six to ten weeks in length and have been predominantly for high school teachers. In contrast, Summer Conferences extend over a one-to-three-week period and are primarily for college teachers. In a few cases secondary school teachers may be included for particular purposes.

As with Summer Institutes, Summer Conferences are directed toward strengthening teachers' mastery of engineering,, science, or mathematics, and increasing their capacity as teachers. A typical Conference might consider a specialized area of engineering, science, or mathematics, or it might be devoted to recent advances in a particular discipline. The material might be presented through short courses or through a series of lectures by visiting specialists. In some cases Conferences might encourage participants to choose specific areas for discussion. Selection of participants is made by the host institutions. College and university staff members wishing to participate will submit applications directly to the sponsoring school, *NOT* the Foundation. Announcements of the sponsoring institutions will be made by the National Science Foundation about February 1, 1960.

Conferences and institutions are representative of the several Foundation programs directed toward improving the teaching of engineering, science, and mathematics. Information concerning other Foundation programs for improving science education in the United States can be obtained from the National Science Foundation, Washington 25, D. C.

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College and University Research

U. S. Colleges and Universities increased their scientific research and development expenditures 80 percent between 1954 and 1958, a National Science Foundation study shows. Preliminary results of the study were issued today in *Reviews of Data on Research and Development*, No. 19, "Funds for Research and development in Colleges and Universities, Fiscal Year 1958."

Expenditures reflected in the study are those for separately budgeted or "earmarked" funds. They increased from $409.7 million in 1954 to $735.8 million in 1958.

The study shows that in 1958 more than half the total expenditure, $408.3 million, was spent by agricultural experiment stations and Federal contract research centers administrated by educational institutions, while the colleges and universities proper accounted for the remaining $327.5 million. The latter were more oriented toward basic rather than applied research, expending 74% of their funds for this purpose. Experiment stations and contract centers, more mision-oriented, reported 35% and 24%, respectively, for basic research.

Expenditures reported for colleges and universities proper—excluding experiment stations and contract centers—were: life sciences, $139.5 million; physical sciences, $98.6 million; engineering, $66.1 million; and social sciences, $23.4 million.

Comparisons with a 1953–54 study show that Federal expenditures for research and development in colleges and universities proper increased 55% during the same period—from $140.7 million to $217.9 million.

Total indirect cost, or overhead, for conducting current research was found to be 28% of the direct costs.

These statistics were collected by the U. S. Department of Health, Education, and Welfare, Office of Education, under contract with the National Science Foundation.

Copies of *Reviews of Data on Research & Development*, No. 19, "Funds for Research and Development in Colleges and Universities, Fiscal Year 1958," are available from the Superintendent of Documents, Government Printing Office, Washington 25, D. C., for 10 cents.

The Artificial Kidney

• By Fred A. Taylor
ALLEGHENY GENERAL HOSPITAL

The talks from the 1952–1953 season were digested and printed in a booklet, "Chemistry and You." This article is reprinted with the permission of the Pittsburgh Section of the A.C.S.

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Patients in whom some acute stress has caused the kidneys to stop functioning are sometimes encountered in the hospital. Very quickly the salts and water in the body reach abnormal concentrations. Heavy metal (mercury, arsenic) poisoning, barbiturate and oxalate poisoning, and infection are a few of the conditions in which such complications arise. If such a patient had been in good health before the episode, it is to be presumed that if the salts and water in the body can be brought back to normal proportions, the kidneys will again take up the task of excreting urine and regulating the composition of the body as they did before, but time is required for the injured kidneys to recover.

The artificial kidney, which can be of help to such patients, is a machine in which blood from the patient is passed through a long (125 ft.) tube of cellophane sausage casing wrapped in a spiral on a rotating horizontal drum. The drum and casing dip into a bath (26 gal.) consisting of a solution of the important salts of the blood in the proportions in which they occur normally. The blood from the patient's artery is piped through plastic tubing into one end of the cellophane casing and is forced back into the patient's vein by a pump at the other end.

In order that the drum may revolve without twisting the connections there is a syringe-like connection at each end; the inner part is stationary and the outer part revolves with the drum. Lubrication of the moving surface is by glycerine. From the pump the blood flows through an expansion chamber and a nylon gauze filter. The expansion chamber traps any air bubbles; the filter catches any small clots that may be formed. After passing through the filter the blood reenters the patient through a vein.

The plastic tubing, syringe-like connectors and cellophane are all sterilized by heat. After assembly the outside surfaces become contaminated with micro-organisms but the inside remains sterile. The bath is warmed to body temperature so as to avoid cooling the patient.

The blood is composed of about half red blood cells and half liquid or plasma. It is the plasma with which we are concerned. Plasma is a water solution of colloids (proteins) and crystalloids (salts, sugar, urea, etc.) The proteins, being very large molecules, cannot pass through the sausage casing—they are larger than the pores in the cellophane. The water and crystalloids, being smaller molecules, pass rather freely through the cellophane. The red blood cells, visible under the microscope, are obviously too large to escape through the casing.

The process which goes on when the machine is in operation is called dialysis. Water and the other small molecules pass back and forth. The speed at which a given substance passes is dependent, among other things, on the number of particles of that substance in contact with the cellophane. If there are equal numbers on both sides, equal numbers will go through in each direction and there will be no change in concentration on either side. But if there are more particles on one side, then the concentration on that side will be reduced and the concentration on the other increased until they are equal. By placing the salts in the bath in the desired normal concentration, exchange will tend to bring the salts in the plasma to the desired normal concentration. Glucose, a normal constituent of the blood, is added to the bath to balance the effect of the proteins of the blood. This serves to prevent undue absorption of water by the blood. This process is different and less complicated than that taking place in the normally functioning kidney but the overall result under these conditions is much the same.

The principle of using an artificial kidney has long been known but it was not until a means of keeping the blood from clotting without injuring the patient that it became of practical utility. Heparin is now available for inhibiting the clotting of blood.

The present artificial kidney was developed during World War II, in occupied Holland, by Kolff. It has been used on numerous patients and has been demonstrated to be a safe procedure.

To start the operation, the machine is primed with a quart of blood compatible with the patient's blood. Heparin is added to prevent clotting. The blood is pumped around the machine in contact with the bath solution until a tube has been placed in an artery of the patient who has also received heparin. The tube from the artery is then attached to the machine and a needle is placed in a vein of the patient for the return of the blood. A flow of about a quart in five minutes is usual. The amount of blood in the machine is maintained constant by observing the last three turns of cellophane and controlling the pumping speed accordingly. In general a team of at least six doctors and nurses is required to supervise the dialysis. Heparin and calcium must be introduced at intervals. Blood pressure is determined and blood samples are taken for analysis.

Leaks in the cellophane have occurred. The blood colors the bath red. The leak may be quickly found by this means and repaired by cutting the tube at the leak and tying in a short length of glass tubing. The blood loss is so small as to be inconsequential.

At the end of the dialysis, which lasts about five hours, the arterial flow is stopped and the blood from the machine is pumped into the patient, taking care that the blood vessels are not overloaded as indicated by rising blood pressure. The remainder is of necessity wasted.

Seven patients have had the benefit of dialysis at the Allegheny General Hospital. Six of them have been in such condition, due to poisoning by arsenic or mercury, that there was little hope of recovery. All recovered.

Until some better means of caring for such patients has been developed, the artificial kidney offers an effective and valuable treatment.

AO Reports on Teaching with the Microscope

Chemoreception in Protozoa...and what makes Daphnia's heart beat faster

Two Biology teachers, one from Middletown, Connecticut and the other from right here in Buffalo, N. Y. submitted teaching experiments that reached us on the same day. In some respects, these two experiments are so much alike as to suggest a sort of pedagogical telepathy. However, they are definitely different and we were happy to get both. Each has a certain classic simplicity, showing the straight line between cause and effect with a neatness that's sure to delight your young student scientists. Since both are relatively short we offer them together with the thought that you may be able to combine them in a single 45-50 minute period.

EXPERIMENT

Effects of Drugs Upon the Heart

By: Ted Stopyra
Middletown High School
Middletown, Connecticut

MATERIALS AND EQUIPMENT

1. AO Spencer 66 Microscope.
2. Daphnia (water fleas) obtainable from any aquarium supply store where they are sold as food for tropical fish; or from biological supply house.
3. Concave microscope slides (or plain slides).
4. Medicine droppers.
5. Different types of drugs (pill or liquid form) which may be diluted to strengths, as desired. The following drugs may be obtained from a co-operative physician.
   - A. Tranquilizers—Compazine.
   - B. Barbitol—Aberate
   - C. Depressants—Altarax
   - D. Stimulants—Dexedrine Sulfate, Wyamine Sulfate.
   - E. Alcohol—40%, 50%, 60%, 95%.

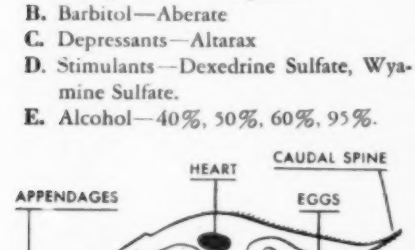

Fig. 1 **DAPHNIA**

PROCEDURE:

1. Select one or two of the Daphnias from a culture with medicine dropper and deposit on concave slide. With same dropper, withdraw as much water as possible from slide, leaving just enough to keep Daphnia alive.
2. Place slide under microscope and observe under 10X objective. One observes the transparent animal immediately with the heart beating very rapidly.
3. Place a drop of one of the diluted drugs on the slide; the heart will react immediately. By repeating the experiment with remaining drugs one can observe the relative effects of tranquilizers, depressants and stimulants on the heart.

EXPERIMENT

The Reactions of Protozoans to Nutrients and/or Dissolved Substances

By: D. S. Po-Chedley
D'Youville College
Buffalo, New York

MATERIALS AND PREPARATIONS

1. Culture of Paramecia or Euglena (obtained from biological supply houses and easily subcultured in finger or stacking bowls).
2. Capillary pipettes: prepared by drawing out medicine dropper so that the bore is about 1mm diameter.

   Capillary tubes—about ½ in. long—prepared the same way, or, 1mm diameter capillary tubes can be purchased from scientific supply house.
3. AO Cycloptic Stereoscopic Microscope.
4. Syracuse dishes, or watchglasses or Petri dishes.

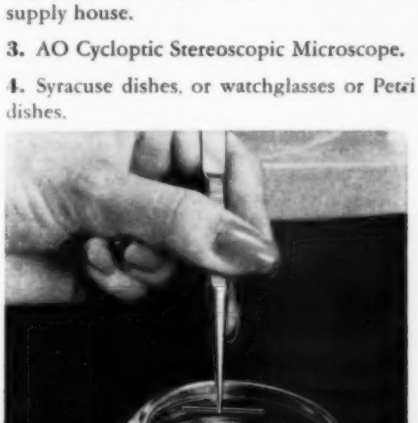

Fig. 2

PROCEDURE:

The plan is to keep the fluid additive in a restricted region long enough to permit the cells to differentiate between it and their normal environment.

1. Fill Syracuse dish half full with water.

   Fill capillary tube with a test solution, viz: sugar, salt, glacial acetic acid, formic acid, alcohol, calcium carbonate, etc. (the tube fills easily via capillary attraction).
2. Use the stereoscopic microscope and capillary pipette to gather a quantity of the organisms.
3. Place the Syracuse dish in focus under the stereoscopic microscope, carefully lay in the nutrient tube with forceps, (Fig. 2) add the microorganisms (Fig. 3)—observe results.

Fig. 3

OBJECTIVES:

This experiment illustrates a protoplasmic property called chemoreception. The cells either respond positively, by clustering around the open regions of the capillary tubes where diffusion of the test fluid occurs or they may respond negatively, by contacting the material and rapidly moving away. It may kill instantly so that a ring or arc of dead cells form at the periphery of the diffusing substrate. This principle, of chemoreception, here associated with the single cell reactions of protozoa may be projected to study the behavior of more complex organisms.

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Medicinal Agents from Petroleum

• By William S. McClenahan
MELLON INSTITUTE

This article is from a series of radio talks sponsored by the Pittsburgh Section of the American Chemical Society.

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In this age of the automobile, the airplane and the oil burner, it is rather hard for many of us to realize that less than one hundred years ago the major use for petroleum was not as a fuel, but as a medicinal agent. For many centuries mankind in various parts of the world had employed crude oil in treatment of many kinds of ailments, both external and internal, and the Indians living in New York and Pennsylvania introduced the remedy to the early American explorers and missionaries. In those days petroleum wells as such were unknown, but in some regions oil was encountered floating on streams or as an unwanted by-product from brine wells. The more enterprising peddlers and merchants of the time bottled the skimmings from the ponds and found a ready market for the product in spite of its smell and taste. Because the oil was produced by nature itself it was widely believed to be a remedy for almost every disease a man could name.

One of the more successful druggists who dealt with petroleum was Samuel M. Kier of Pittsburgh. When he found that his merchandising efforts (which included the original travelling medicine show) had flooded the medicinal market, he attempted to devise methods for using the excess petroleum as a fuel for lamps. His efforts met with moderate success, and eventually interest in oil grew to such an extent that a group of businessmen hired "Colonel" Edwin L. Drake to drill a petroleum well near Titusville, Pennsylvania. By a near-miracle Drake struck oil in 1859 at a depth of 69 feet, and this achievement really marked the beginning of the vast petroleum industry that we know today. At the same time Drake's discovery greatly reduced the use of crude petroleum in medicine, for when oil became plentiful the mystery surrounding it disappeared and people lost faith in its ability to cure.

Nevertheless certain medical uses for crude petroleum and related materials exist even today. Ichthyol and shale oil, for example, are valuable for treating some types of skin disorders. These materials are similar to petroleum in many ways, but there is one important distinction: shale oils do not exist in the ground as such; instead they are formed by heating oil shales until the organic matter in them decomposes to form an oil. The medicinal value of these relatively crude shale oils is probably related to the fact that they contain a high proportion of sulfur compounds.

At present several refined forms of petroleum are very important in pharmacy and medicine. Petroleum is an exceedingly complex mixture that is composed mainly of compounds of carbon and hydrogen. When crude oil is distilled, the gasoline boils off first, followed by naphtha, kerosene, gas oil and lubricating oil. If the lubricating oil fraction is chilled to remove wax and is then treated properly with concentrated sulfuric acid, the product is a completely colorless and odorless medicinal oil that is free from all irritating impurities. Oils of this kind may be taken internally, but their use should be limited to medicinal purposes; they should not be employed as substitutes for edible oils even though they are nonfattening and are low in cost. These purified mineral oils are common constituents of some types of nose drops, baby oils, hair oils and many cosmetic products.

Petroleum jelly or petroleum (often marketed under the trademark "Vaseline") is another important pharmaceutical product. It is a mixture of petroleum oils and waxes that often has a consistency like that of soft butter. Petrolatum is manufactured from residual fractions obtained in the distillation of petroleum. Pharmaceutical grades of petrolatum are light in color because they have been filtered through beds of fuller's earth or bauxite, both of which are very good decolorizing agents. The refined product is widely used as an ointment base, as a remedy for minor sores and irritations, and as a burn dressing. The treatment of severe burns is a difficult matter and many differ-

(*Continued on Page 63*)

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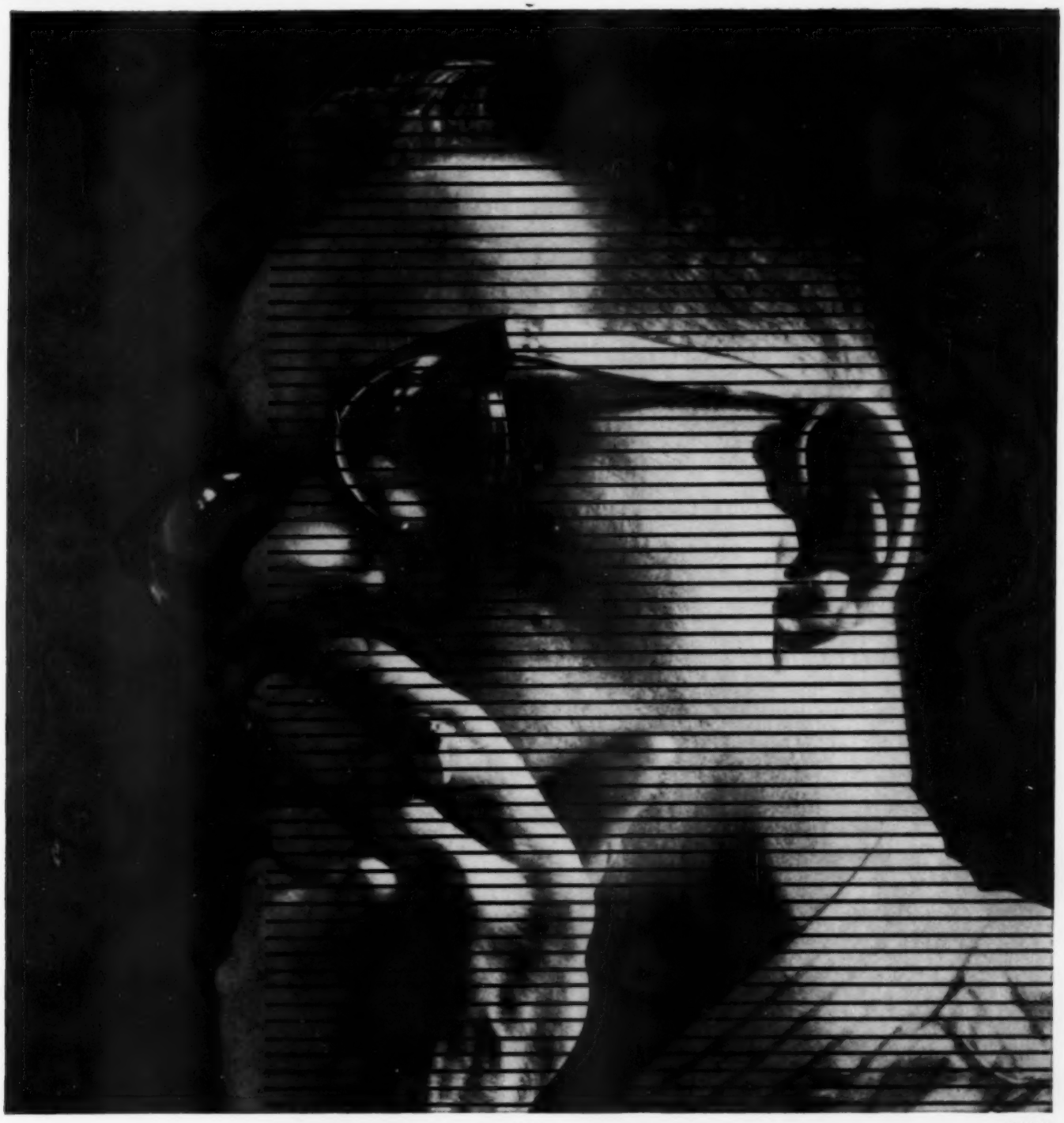

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New Books

Modern High School Chemistry

• *Edited by* EDWARD F. PIERCE, Bureau of Publications, Teachers College, Columbia University, New York, 1960. Pp. 109. $1.50.

The latest Science Manpower monographs, in their present series to improve the teaching of Science, is called *Modern High School Chemistry—a recommended course of study*, which is written for publication by Edward F. Pierce.

The monograph is designed to serve two purposes; one, teachers may desire to employ the recommended course of study in its entirety, and, two; others may prefer to use it as a guide in modernizing the content of existing courses.

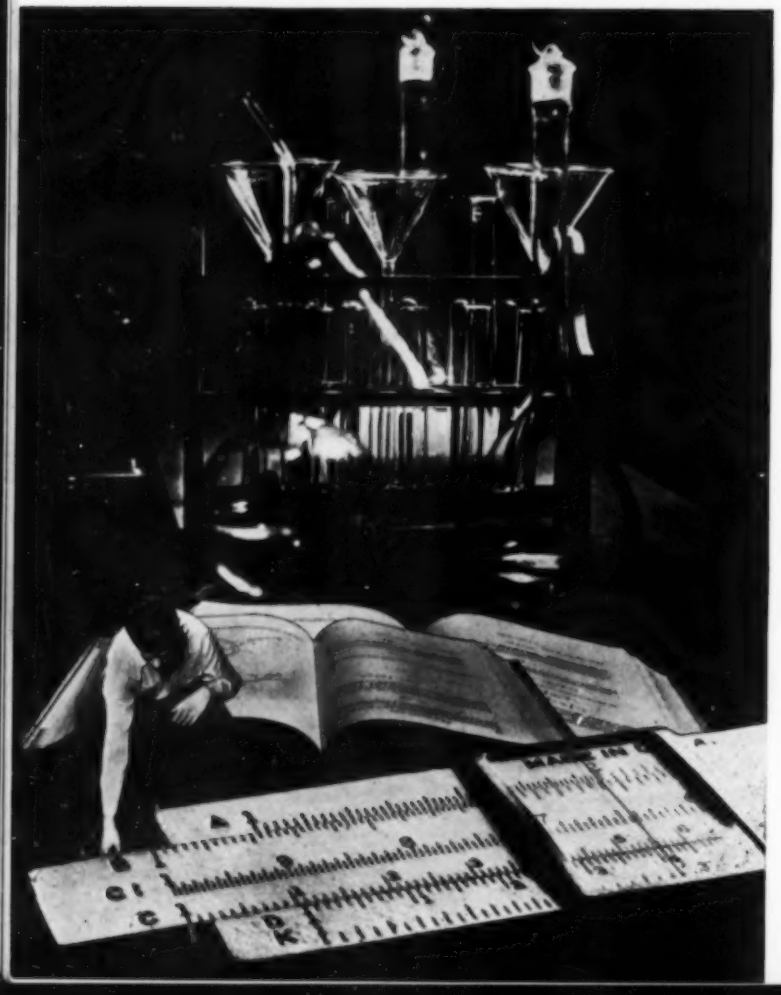
The monograph is divided into three parts. The first part gives a brief historical evolution of cheimstry and science while part two points out the generalized concepts that are needed to unify chemistry. The third part details these unifying concepts with an appropriate breakdown into sub-sections.

The author suggests that to be meaningful Chemistry needs an integrated theme utilizing some basic unifying concepts. These concepts or areas include (1) energy, (2) atomic structure, and (3) equilibrium with other lesser ones suggested.

Within the scope of these concepts, the authors call for a more quantitative approach added to the present qualitative approach. However, this is to be accomplished by utilizing the measurements, calculations, and computations within the qualitive experimentation rather than divorced from it.

This is a fine suggestion, I believe, as it not only integrates the mathematics involved, but it gives more meaning to the techniques and skills that are acquired.

The monograph further elaborates each of the three areas, energy, atomic structure, and equilibrium, by detailed explanations and definite course outlines. The present in-service teacher can integrate his work into this scheme by a slight reorganization and reshuffling with possible elaboration of presently used experiments and demonstrations. However, more reliance on supplementary materials seem evident.



The outline is based primarily on physical chemistry but organic chemistry with a sub section, biochemistry is considered in area three, equilibrium.

It would seem that if using as a course outline and to be successful, a teacher must have an excellent background in the general aspects of physical chemistry, with a firm mathematical foundation.

A few problems could arise from the suggestions in the monograph, but this might be good inasmuch as it should stimulate a teacher to seek answers.

Problems:

1. Teachers, in general, will need to improve their content backgrounds by added summer school institutes especially in theoretical chemistry.
2. Pupils may find the approach more difficult than the present approach not only from a content standpoint, but also from the amount of time devoted to laboratory work. However, by careful selection of topics, experiment, and demonstration, the teacher can overcome this difficulty to a great extent.

The monograph reveals a fine knowledge of the problems in the teaching of chemistry. Teachers can benefit from an organizational viewpoint by studying it. The monograph is stimulating and provocative enough to be used in a discusison relating to possible curriculum modifications to be made in our present chemistry course and is an effort in the right direction to make our courses more integrated, more meaningful, more "sophicated" and with much less wasted energy than at the present time. The monograph when added to the other publications of the Science Manpower Project series give scope and sequence to our present trend of upgrading and strengthening of the science curriculum.

M. A. Shampo
Assistant Professor
Duquesne University

The Edge of Objectivity

An Essay in the History of Scientific Ideas

• *By* CHARLES COULSTON GILLISPIE. Princeton University Press. Princeton, New Jersey. 1960. Pp. 562. $7.50.

This is a most significant book and should become a classic in the field of the history of scientific ideas. The achievements of the great men in science are presented in their full setting and not as isolated developments. For example in discussing Galileo he points out how his thinking was influenced by the revival of Greek learning and the renaissance spirit and also his influence on subsequent thinkers. In discussing others he does not neglect the influence of rationalism, the enlightment, romanticism, positivism and other factors influencing the spirit of the age. In a little over 500 pages the development of science from Galileo and Copernicus to our present day is discussed, and the influence of the introduction of methods based on observation, measurement, and experimentation have contributed to the development of the objective character of modern science.

This book should be in every college library and teachers of the history of science should investigate it as a possible text. It can be highly recommended for supplementary reading in programs in science, the humanities, philosophy and the social sciences.

J.P.M.

"You and Your World"

"You and Your World" by BRANDWEIN, HOLLINGWORTH, BECK, BURGESS, and STRAHLER, copyright 1960, is a revised

and expanded edition of the first book in the General Science Series, *Science For Better Living*, published by Harcourt, Brace and Company. The basic purpose of the book is to introduce the junior high school student to the world of science which is all around him and of which he, himself, is a vital part. Specifically, the purpose of the first four units is to acquaint the student with his own body and behavior and to develop a sense of responsibility within him toward each. The last four units describe the world around him from his own backyard to the heavenly bodies and attempts to stimulate the reader to further study of natural phenomena.

Relatively simple, but accurate facts support each subject covered and many diagrams and experiments offer proof of the validity of the statements made. These facts are used as a means of understanding, not as an end in themselves and new concepts are developed in a clear and orderly fashion. The authors are careful to keep their readers mindful of the many things still to be learned about this world of ours. The challenge to work toward contributing to mankind's growing understanding of the universe is vividly presented.

The style is clear and direct. The vocabulary is generally simple, but adequate. The photographs, drawings, and charts included are excellent. Respect for the intelligence of the seventh grade reader for whom the book is intended was evident. Indeed, the book clarified points for me, the adult reader, upon which I was hazy or unfamiliar.

The authors and editorial collaborators are experienced teachers with a wide knowledge of classroom problems, subject matter, methods and science curricula. This is the first of a series of science books which they have written.

I feel that this is a fine book to use as an introduction to general science and not only the junior high school student, but anyone with a limited scientific background would profit by studying it. I would not hesitate to pick it as a textbook for a seventh grade science class.

Submitted by *Ruth R. Bub*
Student, Duquesne University
School of Education

You and Science

- New Edition, The Science Better Living Series, *by* PAUL F. BRANDWEIN ET AL. Harcourt, Brace and Company, Inc., New York. 1960. Pp. 702. $4.84.

You and Science is a textbook of general science for secondary schools. Its aim is to develop and maintain student interest, establish the necessary concepts and build concepts into conceptual schemes. The material in this book is divided into eight units including the study of the ways of the scientist and the ways of learning, the human body and preventing disease, earth and space, the weather, atoms, chemicals and minerals, plants and soil, and machines and communications. The special features of this text are sixteen pages of full color teaching charts on "Atomic Energy," "Corn—A Seed Plant," and "The Frog"; up-to-date reading lists; an expanded program of student activities; and an increased science vocabulary in the text and the glossary.

The material is presented in readable style with numerous excellent illustrations. In addition to the science inventories which precede each chapter, there are 160 experiments, 103 chapter-end activities and 45 investigative projects designed to aid the student to learn by doing. These features make possible provision for individual differences and valuable suggestions on this subject are included in the accompanying teacher's manual.

The new edition of this text is a revision expanded by 76 pages to include the up-to-date material now being demanded by science courses. The new material concerns high altitude flights, rockets, satellites, space stations, atomic fall-out, atomic power, atomic fusion and a complete new chapter on Electronic Messages.

Accompanying the text are the teacher's manual, the revised student workbook, Experiences in Science, A and B forms of objective tests in an enlarged format and a set of filmstrips in full color with a booklet of teacher's lesson plans.

This book together with the workbook and filmstrips is a thorough and stimulating introduction to the study of all fields of science of an excellent survey of science.

Marylin Owens
School of Education
Duquesne University

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Six new titles in the Science Library can be strongly recommended to all teachers of science and mathematics, undergraduate and graduate students, and college professors.

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The Philosophy of Science by STEPHEN TOULMIN (Pg. 176 $1.25) and **From Atomos to Atom** by ANDREW G. VAN MELSEN (Pp. 240 $1.45) are two books that should be studied by every serious teacher of chemistry and physics and also by all interested in the philosophy of science. Dr. Van Melsen's work was reviewed in the December, 1952 issue of the *Science Counselor*. Dr. Toulmin's book is one of the best discussions of the relationship of science to philosophy available today.

The non-scientist and scientist who is seeking to find what is meant by explanation in science, will find R. B. BRAITHWAITE's **Scientific Explanation** (Pp. 374 $1.85) a most valuable book. Scientific methodology, theory, law, the use of models and probability are clearly discussed. While a knowledge of the calculus would make it easier to read those whose mathematical background is limited will be rewarded for his efforts. Scientists and teachers will find this a thought-provoking book.

Physics and Microphysics by LOUIS DE BROGLIE (Pp. 286 $1.50). No one who is interested in the scientific, philosophical or historical aspects of modern physics can afford to overlook this classic. It is written with a degree of clarity and accuracy that only one who is at the same time a specialist and a philosopher can attain.

College educators who are interested in establishing an honors reading program or recommended reading list should investigate this series.

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And There Was Light by RUDOLPH THIEL (Pp. 384 plus 32 page inset of photographs $0.75) is a popular, well-written and comprehensive history of astronomy. It is well illustrated with photographs and line drawings. **The Oscillating Universe** by ERNST J. OPIK (Pp. 144 $0.50) can be best described as a study of the cosmos from the viewpoint of man on the earth. The origin of the earth, moon, planets and our neighbors in space are discussed along with the principal theories of modern cosmology. Those who are unacquainted with modern astronomy and cosmology

(*Continued on Page 59*)

Problems in Photosynthesis

(*Continued from Page 39*)

phate) is one of the first products of photosynthesis. "The Oxygen is liberated as a stable molecule, but, through a series of intricate steps, some of the energy-rich hydrogen atoms are combined with carbon dioxide" . . . to form a triose sugar (sugar with 3 C atoms)—phosphate—then perhaps a glucose-phosphate, at the same time reducing ATP to ADP (adenosine diphosphate).

4. Glucose splits off the inorganic phosphate which is imemdiately "seized" by ADP forming ATP (a high energy compound). Glucose, also a high energy compound, as everybody knows is the same as dextrose derived from corn starch in the form of corn syrup. It is sweet, soluble in water, saliva, gastric juice, blood plasma and the cell sap of the plants in which it is first formed. Under certain conditions, glucose molecules condense into larger molecules of maltose, dextrin, starch, hemi-cellulose and cellulose. Fatty acids and glycerol as well as several amino acids may be produced in the cells that produce glucose. *There are certainly more products of photosynthesis than oxygen.* This is the most important fact to remember.

5. We note the tremendous importance of inorganic phosphates to the entire process. Although inorganic phosphates are sold to gardeners and farmers as plant food, biologically they are not foods in the strict sense of the term, which should apply to foods in a plant, foods in an animal, and foods in a grocery store. When inorganic phosphates are combined by chemical bonds to ADP, a great energy storing system is set up in the living cell, namely ATP. The energy is found in "chemical bonds," electrical in nature because they involve electrons in motion at rather high velocities in atomic orbits. The magnetic fields set up thereby can interact and form an invisible "cement" that holds these tenuous atoms together in rather stable compounds.

Many problems in photosynthesis are not yet resolved. Some of the best biochemists in the world are working on them diligently. The effort involves a knowledge of much basic science and some mathematics, but particularly modern chemistry, biophysics, and atomic physics, even quantum theory. The electron microscope has been used to magnify the grana and to show the fine structure of the chloroplasts, which are themselves just too tiny for the naked eye to see—just a green "blur" in the green world of nature.

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Book Reviews

(Continued from Page 57)

will find both books most useful.

Gestalt Psychology by WOLFGANG KOHLER (Pp. 222 $0.50) is a paper back reprint of one of the classics of gestalt psychology. **Three Essays on Population** by THOMAS MALTHUS JULIAN HUXLEY and FREDERICK OSBORN (Pp. 144 $0.50) is a mentor original and it presents three of the most frequently used references in discussions of the population problem.

Review of Mathematics

• *By* FESTUS MINNEAR AND RUBY M. GRIMES. W. H. Freeman and Company. San Francisco, 1960. Pp. 198. $1.65.

This is a valuable book for the beginning science or engineering student who is weak in mathematics. It is well arranged and can be used for private study by the student or can be used for a refresher course. Answers are provided for the odd-numbered problems. This is a good book to recommend to students for outside summer-study.

J.P.M.

Free and Inexpensive Learning Materials.

• Tenth Edition. Division of Surveys and Field Services. George Peabody College for Teachers. Nashville, Tennessee, 1960. Pp. 252. $1.50.

This is a valuable book for teachers who want to take advantage of the many free and inexpensive teaching aids that are available from industry, the U. S. Government, foreign embassies, foundations, etc. There are 3,633 entries and each has been evaluated for its usefulness in instructional programs.

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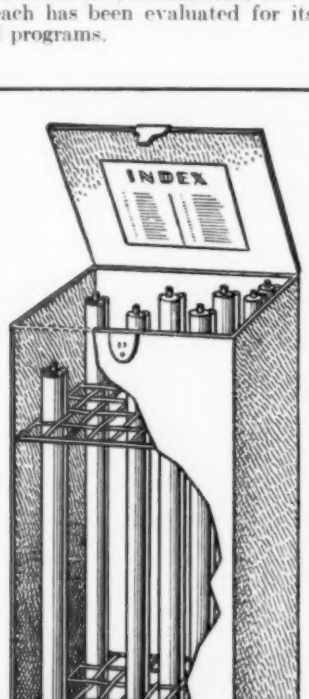

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Responsibility of Knowledge

(*Continued from Page 42*)

It is evident in studying the history of this struggle, that philosophers in the middle ages believed that the will was not *free*, in the pursuit of truth which was not based on Revelation. This accounts for the authoritarianism and intolerance of this period. It is hardly surprising, then, that the introduction of the material sciences into the intellectual life, should have been accompanied with some friction. It was a very normal milestone in the intellectual evolution of mankind, one which will be frequently repeated. Little by little, understanding and charity has smoothed this ruffled sleeve of history until the Church can look with pride upon the genius of her adopted son John Henry Newman, who set down the terms of the Church-Science concordat in the following way:[4]

> "He who believes in Revelation with that absolute faith which is the prerogative of a Catholic is not the nervous creature who startles at every sudden sound, and is fluttered by every strange or novel appearance which meets his eyes. He has no sort of apprehension, he laughs at the idea, that anything can be discovered by any other scientific method which can contradict any one of the dogmas of his religion. He knows full well there is no science whatever but, in the course of its extension, runs the risk of infringing, without any meaning of offence on its own part, the path of other sciences; and he knows also that if there be any one science which, from its sovereign and unassailable position can calmly bear such unintentional collisions on the part of the children of earth, it is theology. He is sure, and nothing shall make him doubt that, if anything seems to be proved by astronomer, or geologist, or chronologist, or antiquarian, or ethnologist, in contradiction to the dogmas of faith, that point will eventually turn out, first, not to be proved, or, secondly, not contradictory, or thirdly, not contradictory to anything really revealed, but to something which has been confused with Revelation."

In the eyes of Newman, Science, like all knowledge, is "ministrative to the Catholic Church, because truth of any kind can but minister to truth." If this principle is itself not novel, the calm, scholarly and detached way in which Newman applies it, is. To the scientific investigator of his university, he gives the counsel:

1. Not to come into collision to dogma.
2. Not to embark upon any interpretation of scripture.
3. Not to teach, even in his own science, religious paradox.
4. And finally, to avoid recklessly scandalizing the weak.

Having given these counsels, Newman[4] goes on to say:

> "A scientific speculator or inquirer is not bound, in conducting his researches, to be every moment adjusting his course by the maxims of the schools or by popular traditions, or by those of any other science distinct from his own, or to be ever narrowly watching what those external sciences have to say to him, or to be determined to be edifying, or to be ever answering heretics and unbelievers."

It is paradoxial that the discourses from which these quotations were taken should be the product of years which

Newman himself was to consider failures. Yet, this very scholarly statement of the rights and duties of the scientist in relation to the Church, will ever reach the fame and fruit of any University which he might have founded. In contrast to the intolerance of the Middle Ages, Newman has introduced a patient and confident wisdom based on a firm belief in the sovereignty of truth. Under his influence the theologian is appeased and the scientist encouraged.

In a more contemporary and practical outlook on this problem, one could wish to see a better understanding of science on the part of all the clergy and all teachers in Catholic schools. Too often one encounters an attitude of tolerance only, and in certain matters, such as evolution, very little regard for the scientific data. Certainly the fault is not all one way and this is a time when good expositors of science are needed. A rapproachement between the non-scientist and scientist could be of great help to Catholic education in curing one of its chief faults viz. "spoon feeding" especially in matters of *religion* and *philosophy*. Free discourse in these two disciplines, which is at least so safe if not expedient, is simply essential and necessary in science. Its spirit of anti-dogmatism is then, a real stimulus to any intellectual milieu.

Aside from the unending freshness of its approach, science has much to offer in this day to Catholic intellectual life. More than any other discipline, it can act as the ambassador of Catholic culture in a world of materialism. And conversely, through its external contacts enrich its own culture. There is a mysticism in the scientific drive for truth which can provide inspiration and hope for all who come in contact with it. I believe that the opinion and activity of scientists today, is vital in all fields of Catholic endeavor, from the parochial school upwards, not because the man with scientific knowledge is more clever but because without him the view of the universe is onsided. For the scientist, participation in these endeavors is part of the responsibility of knowledge.

Whatever be our present esteem in the eyes of society, and I believe it to be growing all the time, I hope that by our light, our learning and our labor, we can convince all people to see the scientist in the vein of the poet William Blake:

To see a World in a Grain of Sand,
And a Heaven in a Wild Flower,
Hold Infinity in the palm of your hand,
And Eternity in an hour.*

* This last piece of advice is all too often neglected by scientists who are eager to spread their new ideas in every by-way. It was the fault of the 15th century Humanists. In their eagerness they forgot the limitations of the scientific method itself.

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2. Francis Bacon—Novum Organum, Book I.
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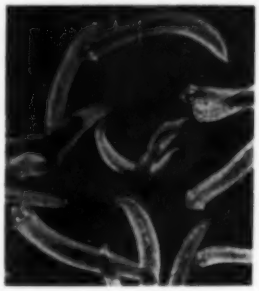

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Aspects of Evolution II

(Continued from Page 46)

to be without having also a scientific knowledge of the way his spiritual activities are bound to material activities. This is the consequence of man being a spirit-in-matter. In and through matter he has to realize his self. It is well-known in medical science how sometimes bodily structures prevent man from being himself. Perhaps in the long run science will succeed in improving these structures and so open up new possibilities of spiritual life for many people who now partly or wholly are deprived from it. These possibilities throw a new light on the problem of evolution, for they show the essential difference between pre-human evolution and human evolution and as a consequence also the essential difference between man and the rest of nature. With man a new original factor appears, the spiritual, and with it a new type of finality, which takes the course of evolution in its own hand, not by neglecting the blind forces of nature, but by studying and directing them. Finality, on the human level, therefore, can be considered as the fulfilment of the inherent tendencies of matter, the unfolding of what they are meant to be. In pre-human evolution the law of the survival of the fittest is one of the driving forces. With human evolution a new law appears, the care of man for his fellow-men, especially the weak and miserable, the unfit, for with the appearance of man a kind of being came into existence in which each individual was a person. If it makes sense from the viewpoint of pre-human evolution to speak of man as the product of material forces, from the viewpoint of human evolution it makes even more sense to say that the ultimate meaning of matter should be found in man. If we want to understand the mystery of the material world, we should look at man, for in man a little of that mystery is revealed to us.

The theory of evolution is usually considered as a degradation of the status of man. It is the purpose of this paper to stress that we can better consider it as an elevation of the status of matter, for evolution shows the meaning of its potencies and tendencies.

1.

2.

3. The difficulties to define life confirm this thesis. Whatever definition we choose, non-living structures can always be found which more or less answer the definition.

4. Cf. A. G. van Melsen, *From Atomos to Atom*, Pittsburgh, 1952.

5. Cf. Le Comte du Nouy, *Human Destiny*, New York, 1947, III.

6. Cf. A. I. Oparin, *The Origin of Life on the Earth*, London, 1957. (translated from the Russian).

7. Cf. A. G. M. van Melsen, *The Philosophy of Nature*, Pittsburgh, 1954. Ch. V.

Low Frequency Waves

(*Continued on Page 50*)

In one to three hours of measuring time some users have been able to obtain from one to three orders better precision than is possible at HF. Reception of the signal is limited, however, both because of its low power and the greater attenuation experienced at 60 kc as compard with that at 20 kc.

Yet more than 50 organizations have used these signals during the past two years. Each is mailed a weekly brochure with frequency corrections to parts in 10^{11} versus the U. S. frequency standard. Normally these corrections are less than 1 part in 10^{10}. When the signal-to-noise ratio is good users can achieve calibrations to a few parts in 10^{11} in about an hour.

As compared with the 20 kc transmission the 60 kc signal is relatively easy to modulate and, because of propagation characteristics, should offer (with higher power—see 20 kc above) about one order of magnitude higher accuracy for domestic use. The original experimental station has recently been established as a regular service with the call letter WWVB.

The 60 kc transmission, at 40 kw, will be of particular value to the armed services, the NASA, missile ranges in the U. S., government and industrial laboratories, and manufacturers of defense equipment. It is estimatel that the number of such users will exceed 5,000 within five years after activation and this signal will also require moderately complex receivers. Such receivers, including clock, might cost $1,000 in moderate production quantities.

Medicinal Agents

(*Continued from Page 54*)

ent methods have been evaluated by the medical profession. Paraffin wax coatings for the burned area have been used to some extent, but the treatment recommended in recent years by the armed forces of the United States is to cover the burn with a sterile dressing of gauze saturated with petroleum jelly, over which is applied a bulky pressure dressing. This dressing is not disturbed for about ten days, and antibodies are administered to minimize the danger of infection. The pressure dressing helps to prevent the loss of body fluids from the burn, and the petroleum keeps the gauze from sticking to the skin, so that further injury does not occur when the protective covering is finally removed.

Petrochemicals, or chemicals derived from petroleum, are very important sources of medicinal products. Ether, alcohol and glycerine are examples of useful pharmaceutical chemicals that can be manufactured from petroleum. Many petrochemicals are important solvents in drug manufacturing processes, and many also enter directly into the chemical reactions involved in the synthesis of drug products. Thus close relationships between the drug and petroleum industries may be expected to continue at least as long as petrochemicals remain available on an economical basis.

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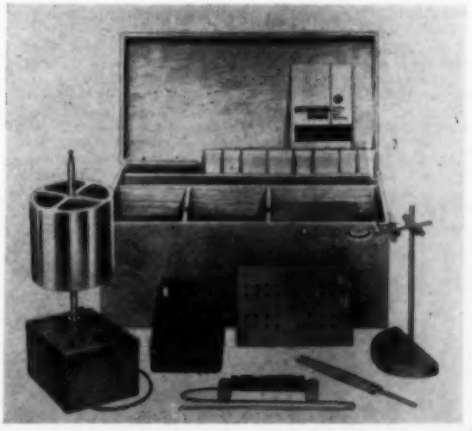

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Nation's Secondary Science Teachers Awards

The Science Teacher Achievement Recognition (STAR '60) program awards were presented March 31 at the Eighth Annual Convention of the National Science Teachers Association in Kansas City. Fifty-six cash awards, ranging in value from $100 to $1,000 and totaling $13,500, and more than 70 certificates of honorable mention were awarded.

The STAR program is sponsored by the NSTA, a department of the National Education Association, under a grant from the National Cancer Institute of the National Institute of Health. The awards are designed to stimulate and recognize promising new practices in high school science teaching, grades 7–12. Dissemination of these ideas is intended to improve the quality of high school science teaching and, in turn, increase the number of students preparing for careers in science.

STAR '60 encouraged cooperation between scientists and teachers with competition open to teacher-scientist teams as well as individual teacher entries. Several of the award-winning entries were joint projects.

The top award of $1,000 was the joint entry of Sister Mary Hermias Mennemeyer, S.S.N.D., chemistry and physics teacher at St. Francis Borgia High School, Washington, Missouri, and Sister Mary Joecile Ksycki, S.S.N.D., head of the chemistry department, Notre Dame College, St. Louis, Missouri. Entitled "Adventures in Radioactivity for High School Students," their project describes over 80 activities with radioisotopes carried on by the students of Sister Mary Hermias.

The top award and the 10 awards of $500, 20 of $250, and 25 of $100 were all accompanied by bronze medallions and school plaques.

Bausch & Lomb Optical Co. provided a microscope to be awarded to the top entry in the field of biology. This, in addition to a $500 award, went to Mrs. Carolyn Alcott Gibson, biology teacher at North Hills High School, Pittsburgh, Pa. Her entry, "Cancer Research Team of North Hills High School Biology Students," was another example of teacher-scientist cooperation. The scientists, Dr. John R. Jablonski and Mr. Joseph Sunder, are doing cancer research at the University of Pittsburgh School of Medicine.

Other award-winning entries were based on such ideas as a device for tracing light rays, an electronic machine for review lessons, the development and use of a Foucault pendulum, a mathematical approach to geotropism, a course of study in advanced biology, a science work-experience program, and a summer science program. A booklet describing the more outstanding STAR '60 entries will be published by NSTA during the coming year.

THE SKY IS THE LIMIT

The fiction of Jules Verne is rapidly becoming fact as the world begins to adapt to a new "space age." Satellites are now in orbit. Sending a rocket to the moon is under active discussion. Outer space travel is sufficiently close for the conducting of military experiments to simulate its conditions.
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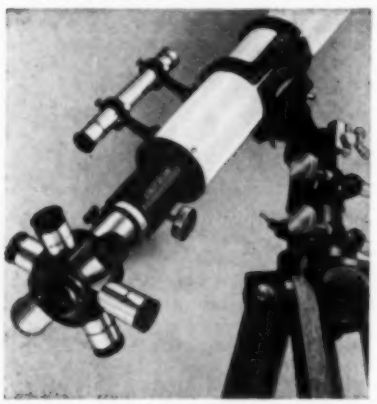

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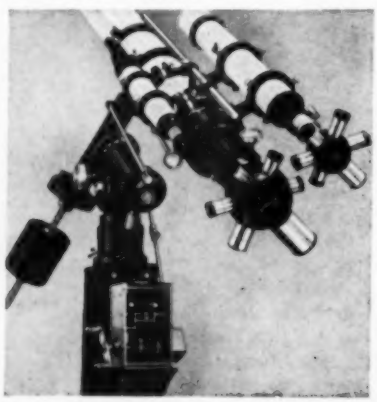

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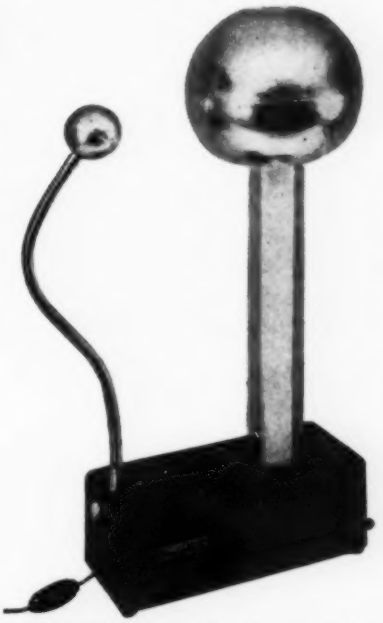

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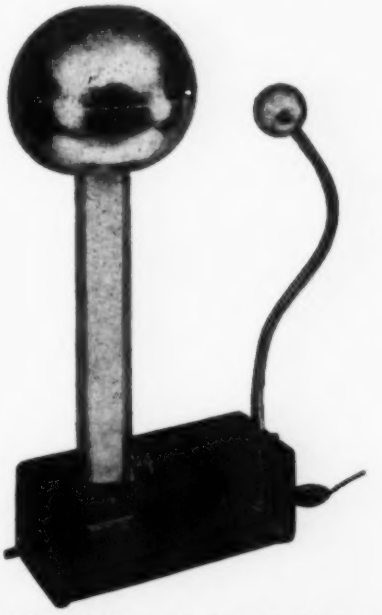

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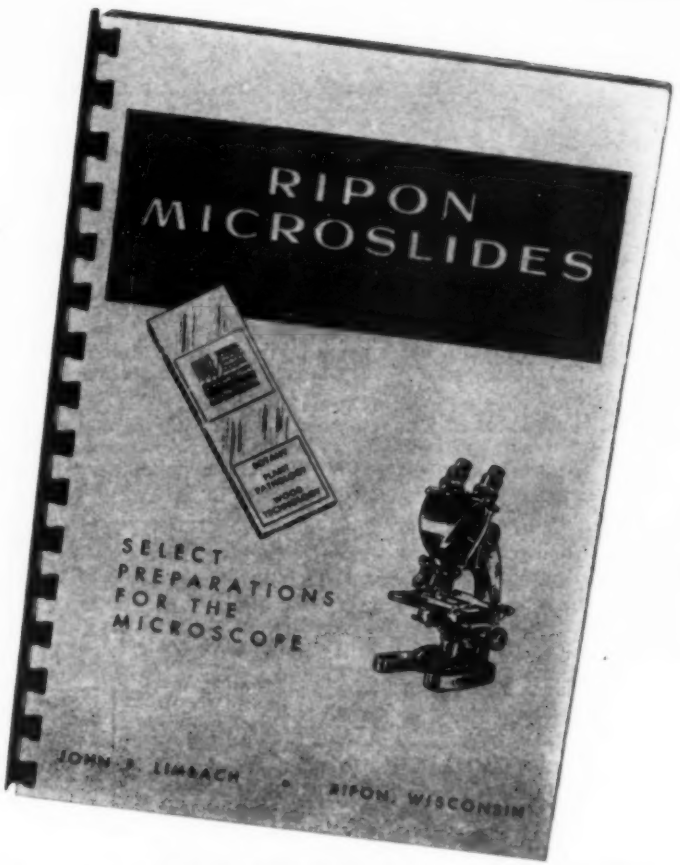

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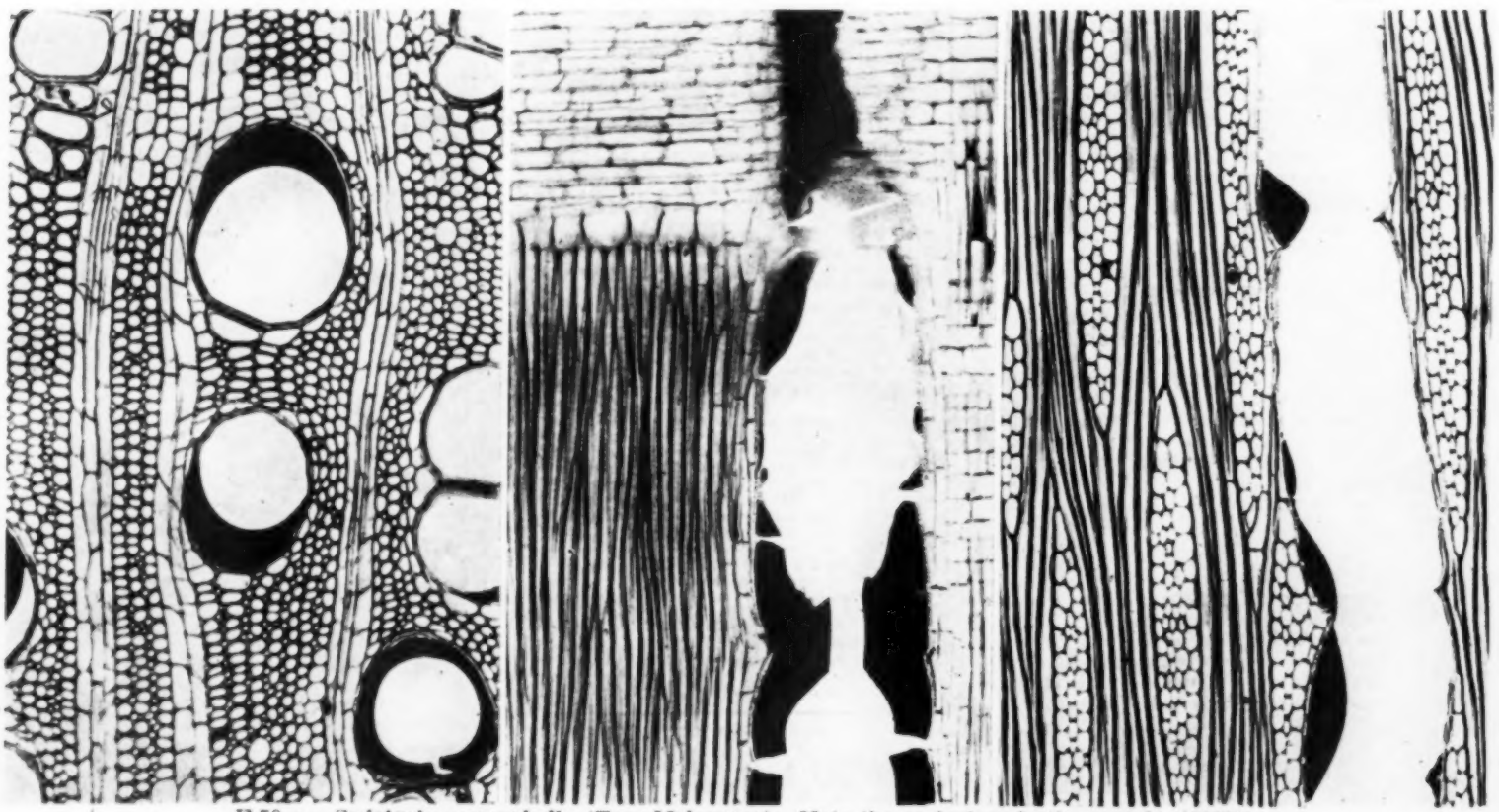

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